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ENVIRONMENT

ALBERTA DEPARTMENT OF THE ENVIRONMENT
WATER RESOURCES MANAGEMENT SERVICE
TECHNICAL SERVICES DIVISION

ST. ALBERT FLOODPLAIN STUDY

Prepared By:	River Engineering Branch
Submitted By:	M. E. Quazi, P. Eng. Branch Head River Engineering Branch

REVISED, NOVEMBER 1990

93-02117/

SUMMARY

The first undertaking to define the flood risk hazard along the Sturgeon River at St. Albert was completed by the River Engineering Branch, Alberta Environment in 1975. The study produced maps delineating the 1%, 2% and 5% floodplain boundaries and provided documentation of the 1974 flood, the largest on record.

In 1984 a second floodplain study was undertaken by the River Engineering Branch in response to a request from the City of St. Albert to extend the existing mapping (1975 study) to include areas affected by recent expansion of the city boundaries. At that time, it was decided to conduct a complete re-analysis of the flood potential along the Sturgeon River taking into account the numerous physical changes that had occurred in the floodplain since the 1975 study. The subsequent report was submitted in February, 1986. The expanded study area extended from the outlet of Big Lake at the western city limits to a point approximately one kilometre downstream of the eastern city limits, in the M.D. of Sturgeon.

In April, 1989, Canada and Alberta signed "An Agreement Respecting Flood Damage Reduction and Flood Risk Mapping in Alberta". This agreement initiated the Canada-Alberta Flood Damage Reduction Program (FDRP) which provides for the identification and mapping of flood risk areas in urban communities across the province. The 1986 St. Albert Floodplain Study was accepted as meeting the basic requirements of the FDRP with respect to hydrologic analysis, surveys and mapping standards. However, it was felt that the existing single-zone floodplain maps should be replaced with new maps defining a two-zone (floodway/flood fringe) flood hazard. This would be consistant with flood risk mapping currently being produced for other Alberta communities under the FDRP.

The present report (November, 1990 Version) contains the revised two-zone flood risk maps, along with a description of how they were determined. This information is contained in Appendix A. Additional technical information omitted from the 1986 report has been included in Appendix B (Flood Frequency Analysis), Appendix C (Model Calibration Results) and Appendix D (Computer Input/Output). The main text of the report is unchanged from the 1986 version.

To reduce the potential for flood damages in St. Albert it is recommended that the two-zone flood risk maps contained in Appendix A of this report form the basis for regulating all future development in the flood prone areas.

ACKNOWLEDGEMENTS

The 1986 Floodplain study was conducted by S. Lowe, P. Eng. and P. LaRocque, B.Sc. of the River Engineering Branch, Alberta Environment. Flood frequency estimates were provided by the Hydrology Branch, Alberta Environment and cross-section surveys were obtained by the Survey Branch, Alberta Environment.

The additional hydraulic analysis and computer modelling required for the floodway determination (two-zone mapping) was carried out by B. Yaremko[1], E.I.T. under the direct supervision of T. Winhold, P. Eng. of the River Engineering Branch. Mr. Winhold was responsible for assembling the Revised (November, 1990) Version of this report.

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[1] Project Engineer, (under contract to the Flood Damage Reduction Program).

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1.0 INTRODUCTION

1.1 General

The study to update the floodplain delineation of the Sturgeon River through St. Albert (Figure 1) was initiated in September 1984. This decision followed a request from the City of St. Albert Planning Department to extend the existing 1975 study(1)* to include areas affected by the expansion of the city boundaries. Because of changes to the floodplain and the replacement and addition of bridges since the 1975 study, a complete revision of the analysis was chosen.

1.2 Previous Study

In August 1975, the River Engineering Branch completed a floodplain study of the Sturgeon River at St. Albert(1). This study delineated the 1%, 2% and 5% floodplain boundaries on contour mapping and was calibrated with a well documented highwater mark survey(2) conducted by the River Engineering Branch in 1974. The extent of the 1974 flooding in St. Albert is shown in an air photo mosaic (Figure 3) flown when the flood was 0.13 metres (m) below the peak water level. The flood had a maximum mean daily discharge of 104 cubic metres per second (cms), or 3670 cubic feet per second (cfs).

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*Numbers in parenthesis refer to list of References on page 14.

The previous flood study of this area used a 1% discharge of 109 cms which was somewhat larger than the 1974 flood. In general, only the low-lying areas and some of the city parks were flooded during the 1974 flood. Flooding was extensive upstream of the railroad bridge and downstream of the city.

1.3 Channel Improvements

Since 1975, the City of St. Albert and some developers have constructed dykes and filled in low-lying areas adjacent to the river. Three new traffic bridges and two walkway bridges have been built in addition to some recreational development. There now exists a dyke on the south bank from the railway bridge (Figure 2) east to a high bank past the new Highway #2 bridge. Landfill has been placed on the left bank at the senior citizen's home and for the apartment complex and the shopping centre near the Highway #2 bridge.

The construction of the above works, after completion of the 1975 flood study, created some uncertainty concerning the validity of the published 1% floodplain boundaries.

1.4 Study Reach

The study encompasses an 8.5 kilometres (km) reach of the Sturgeon River, from the outlet of Big Lake to approximately 1.2 km downstream of the eastern city limits (Figure 2). The study was extended past the city limits to provide for future expansion.

2.0 HYDROLOGY

2.1 Basin Description

The Sturgeon River basin (Figure 4) begins southeast of Entwistle and the river flows through Isle Lake, Lac Ste Anne, Matchayaw Lake and finally Big Lake before passing through St. Albert. From St. Albert it flows northeast to its junction with the North Saskatchewan River near Redwater. Each lake in the system modifies the flood flows, with Big Lake having a significant moderating effect on flood flows at St. Albert. The Sturgeon River basin at St. Albert drains about 2650 square kilometres (km^2). From past experience, this basin has a slow and prolonged response to snowmelt or rainstorms such that the maximum mean daily flow is approximately the same as the maximum instantaneous peak discharge. In this study, the maximum mean daily peak flows were used.

2.2 Causes and Timing of Floods

Since the Sturgeon River basin is located in the plains area, snowmelt is the major cause of most floods. The normal spring snowmelt peaks anytime from late March to early May, with mid-April being an average date. The largest recorded flood flow (1974) was attributed directly to a large snowpack and a very rapid spring melting situation.

Rainfall events can also cause high flows in the basin as several maximum annual peaks have been recorded in June and July.

2.3 Flood Frequency Distribution

The Hydrology Branch of Technical Services Division, Alberta Environment, have prepared a flood analysis report for the Sturgeon River at St. Albert(4). The flood frequency distribution for various discharges is shown on Figure 5. Table 1 below is taken from the above report and provides various flood frequencies and the corresponding flows.

Table 1

Flood Frequency Estimates - Sturgeon River at St. Albert

Return Period (years)	Maximum Daily Discharge (cms)
1:200	111
1:100	92
1:50	75
1:20	55
1:10	42

3.0 RIVER REGIME

The regime of a river or creek refers to the channel characteristics, which can vary on a short-term basis, and are relatively steady over longer periods of time. These channel characteristics which make up the 'regime' of the river include the shape of the channel cross section, the longitudinal profile, the bed configuration, and the channel pattern. The regime characteristics of a river are formed by the water and sediment flows which the river carries, and are therefore related to the flow history of the river and the soil materials through which the river passes.

3.1 River Surveys

Due to the channel improvements discussed in Section 1.3, a new survey was requested so that an up-to-date data base could be prepared. Several cross sections were surveyed downstream from the city limits to provide for future development.

River surveys were carried out by the Survey Branch, Technical Services Division, Alberta Environment, from October to December 1984. In total, 24 (twenty-four) cross sections were surveyed, the locations of which are shown on Figures 9B to 9D. Plots of representative cross sections may be seen in Figure 6, Sheets 1 and 2. To assist the study, the St. Albert Planning Department provided survey access within the city limits.

3.2 Geomorphic Characteristics

The lower reach of the Sturgeon River is described(4) as a streamcut valley with moderately forested valley walls. There exists one fragmentary terrace level. The valley flat contains portions of the city and business district. The surrounding valley is cultivated plain area. Within the study area, the Sturgeon River is a slow moving, underfit stream with few meanders. The channel exhibits little instability and only minor erosion. The very low velocities and gently sloping banks, contributes to the general channel stability in this area. Downstream of the study reach, however, the Sturgeon River develops a severe meandering pattern.

3.3 Hydraulic Characteristics

The Sturgeon River is a very slow flowing river with maximum velocities of 1.2 metres per second (ms^{-1}) during the 1% flood. The average depth at this discharge is 3.5 m and width ranges from a maximum of 1000 m at the upstream end of the study reach to a minimum of 35 m at the highway bridge. Rating curves, which plot discharge against water surface elevation, are presented in Figure 7 for various cross sections within the study area.

4.0 CALCULATION OF FLOOD LEVELS

4.1 Methodology

The floodplain delineation was conducted by calculating a series of water surface profiles for selected discharges. To produce these profiles, a computer program developed by U.S. Army Corps of Engineers', Hydrologic Engineering Centre, entitled "Generalized Computer Program HEC-2, Water Surface Profiles"(6) was used. The program requires geometric and hydraulic data as input. The geometric data consists of surveyed cross sections of the channel and floodplain, including information on bridges. The hydraulic data consists of discharges and hydraulic roughness (friction) coefficients.

Within the program, the water surface profile is computed from cross section to cross section using the 'Standard Step' calculation method. The calculation method is based on applying Bernoulli's Theorem for the total energy of flow at each cross section, and the Manning equation to determine the friction (energy) loss between cross sections(6, 7). Other energy losses, such as flow contraction and expansion losses due to the presence of bridges(8) or culverts, are computed using basic principles of fluid mechanics.

The program incorporates three basic assumptions which are common to the standard step calculation method. These are:

a. that the flow is quasi-uniform, gradually varied, within a rigid boundary;

b. that the flow direction at a cross section is perpendicular to the section (for this reason the cross sections are usually surveyed to be perpendicular to the estimated flow lines); and

c. that the water surface elevation at a cross section is level across that section.

There are three basic phases involved in the application of this computer program. The first is the collection and input of data into the program. The second step is to use the model to reproduce measured flood levels for known discharges. This phase is called 'calibration', and involves adjusting the hydraulic roughness coefficient (for the main channel), until the measured flood levels match those computed by the program. If the model can be shown to accurately reproduce past events, then it can be used with a fair degree of confidence to calculate and predict flood levels for discharges which have not yet occurred.

The third phase is the determination of the 1 in 100 year return flood levels using the calibrated model. The statistically determined flood discharges derived through hydrologic analysis are entered into the model and the resulting water surface elevations are computed and plotted on the topographic or orthophoto maps to determine the extent of the floodplain.

4.2 Geometric Data

The geometric data used to prepare the data base, consisted of 24 surveyed cross sections (Section 3.1). These cross sections included descriptions and elevations of the existing three traffic, one railway and two pedestrian bridges. The previous (1975) data base was not utilized in the preparation of the current data base.

4.3 Manning's Roughness Coefficient

The hydraulic roughness coefficient (Manning's n-value) defines the resistance to flow of a channel and its floodplain. To estimate the roughness values (n), each cross section was separated into overbank areas and main channel. The overbank areas are further subdivided according to land use and vegetation. Examination of air photography supplemented by field reconnaissance and previous experience established values for the overbank area.

4.3.1 Overbank Roughness Coefficient

The roughness coefficients for the overbank portions of the cross sections were chosen from Chow(7) and previous experience. The range of values selected is given as:

Table 2

Typical Overbank Roughness

Overbank Type	Roughness 'n' Range
Pasture, short to long grass	0.030 - 0.035
Brush, scattered to medium	0.035 - 0.070
Brush, medium to dense	0.070 - 0.160
Trees, heavy stand of timber	0.080 - 0.120

4.3.2 Channel Roughness Coefficient

The channel roughness was considered separately from the overbanks as the channel carries the majority of the flow and, as well, the overbank roughness does not change significantly with variations in discharge. Highwater marks surveyed in 1974(2) and 1982(3) were used to verify the channel roughness coefficients for a range of discharges (Section 4.3.3). The calculated channel roughness coefficients ranged from 0.037 for the 1 in 100 year flood to 0.049 for the 1 in 5 year flood.

4.3.3 Calibration

Calibration of a HEC-2 computer model consists of using a known discharge and measured water surface elevations to select an appropriate channel roughness coefficient (for use in calculating energy losses). The discharge is entered into the model and the channel roughness coefficient varied in successive 'runs' until the computed water surface profile reflects the measured profile.

With the selected channel roughnesses (Section 4.3.2) the computed water surface profiles were found to match the measured 1974 profile within 0.15 m. and to match the measured 1982 profile within 0.02 m.

4.3.4 Sensitivity

A significant test to determine the responsiveness of the computer model is to vary the channel roughness coefficient and observe the resulting changes in water surface elevations for a given discharge. This provides an indication of the sensitivity of the model to changes in roughness and also gives an indication of the reliability of the calibrated roughness coefficients.

The mathematical model of the Sturgeon River exhibited only a minor variability in water surface elevation when the channel roughness coefficients were altered significantly. As an example, increasing the channel roughness value by 0.005 resulted in an increase in water levels of approximately 0.05 to 0.1 m.

5.0 FLOODPLAIN DELINEATION

5.1 Base Mapping

The base maps used to delineate the flood risk areas for this study are 1:5,000 scale orthophoto maps with a 1.0 m contour interval. The mapping was produced by the Alberta Bureau of Surveying and Mapping from aerial photography flown in May 1983.

5.2 Flood Risk Maps

To delineate the floodplain, the calculated water surface elevations were transferred directly to the orthophoto maps at each cross section location. Linear interpolation was used to join the water surface elevations from cross section to cross section. The complete 1 in 100 year and 1 in 20 year floodplain delineations are shown on Figures 9A to 9D. Where practical, the 1:50 year floodplain delineation has been shown (at the request of the City of St. Albert). Where flood lines are coincident, only the highest flood is indicated. Corresponding water surface elevation profiles for the 1 in 100, 1 in 50 and 1 in 20 flood levels are shown in Figure 8.

5.3 Extent of Flooding

The flooding on the Sturgeon River during a 1 in 100 year flood is confined to the river channel, dyked areas and some adjacent low-lying lands. Upstream of the railroad bridge, mainly farm land and a small recreation field are subject to flooding. Downstream of the city, major overbank flooding occurs, but it is limited to farm land and undeveloped areas. The newly installed bridges present no serious backup of water. In the event of a large flood, it is extremely doubtful that much debris would be present to catch on the bridge piers and cause a backwater problem.

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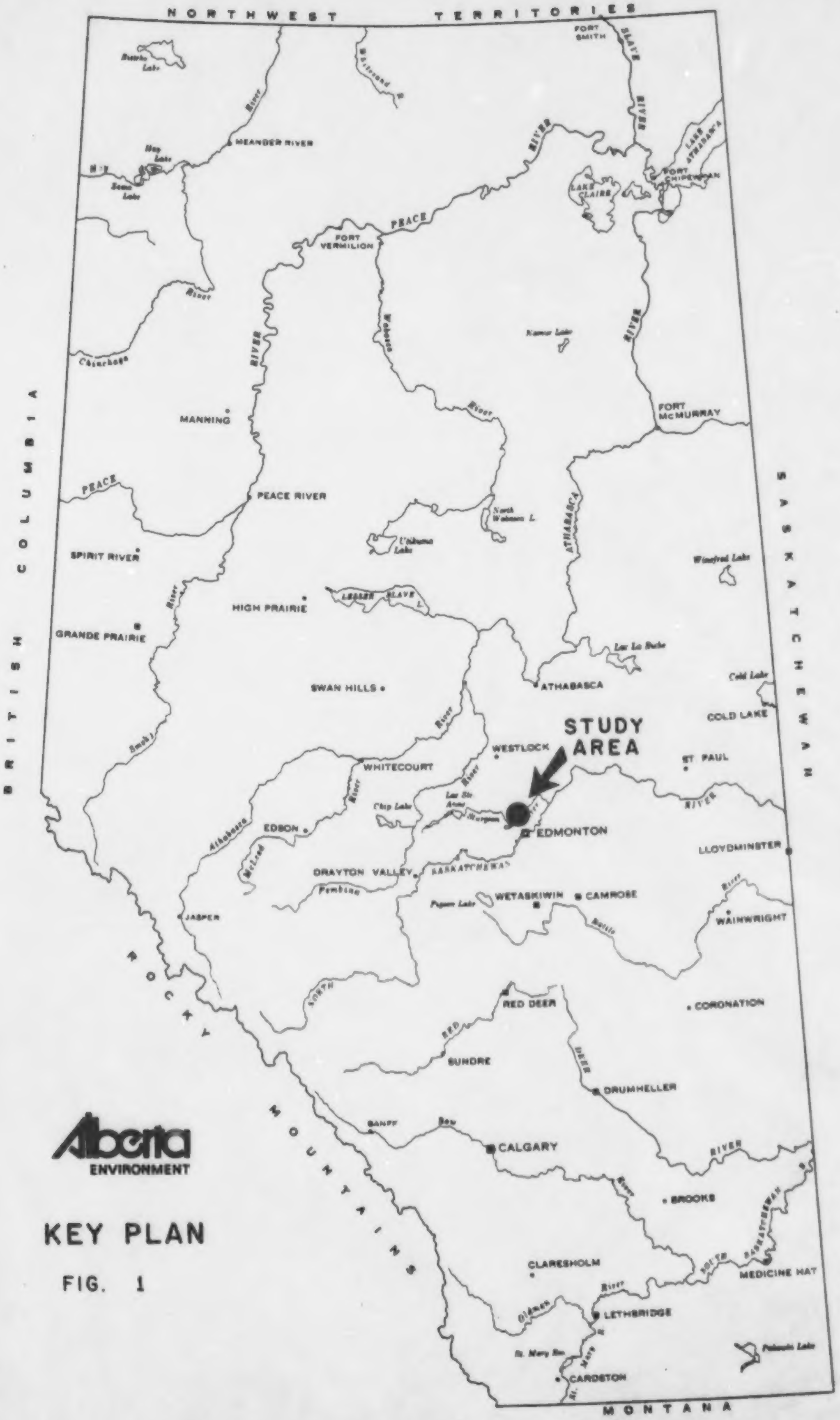
8. Bradley, J.N., "Hydraulics of Bridge Waterways", U.S. Department of Transportation/Federal Highway Administration, Hydraulic Design Series No. 1, 2nd Edition, Washington, D.C., March 1978.

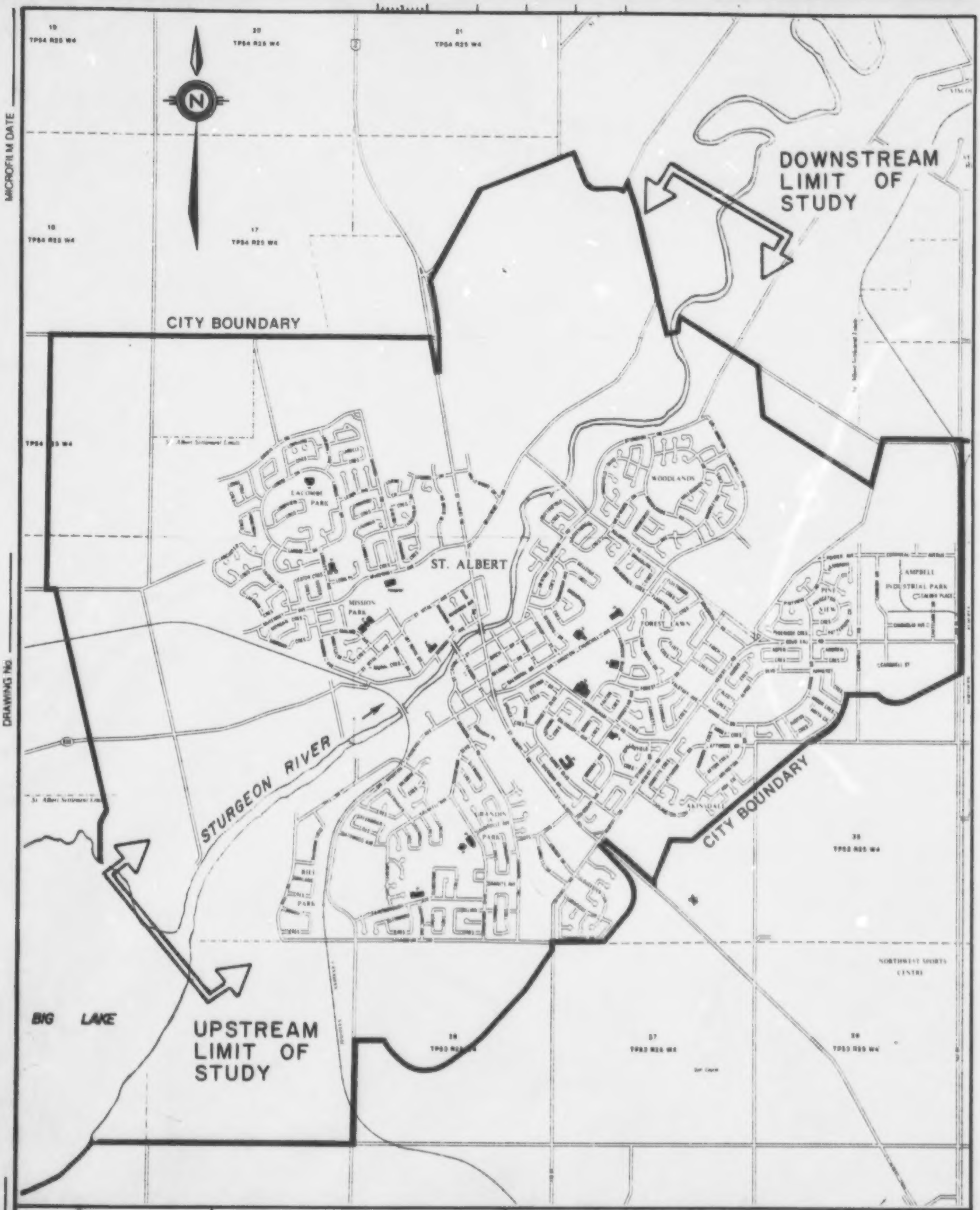
FIGURES


NORTHWEST TERRITORIES
FORT SMITH
SLAVE RIVER
Bistcho Lake
River
MEANDER RIVER
Hay Lake
Zama Lake
Hay
LAKE ATHABASCA
FORT CHIPEWYAN
LAKE CLAIRE
PEACE RIVER
FORT VERMILION
River
Chinchaga
Wabasca
Namur Lake
RIVER
MANNING
FORT McMURRAY
PEACE
PEACE RIVER
North Wabasca L.
Utikuma Lake
ATHABASCA
SPIRIT RIVER
Winefred Lake
HIGH PRAIRIE
LESSER SLAVE L.
GRANDE PRAIRIE
River
Lac La Biche
SWAN HILLS
ATHABASCA
Cold Lake
COLD LAKE
Smoky
River
STUDY AREA
WESTLOCK
ST. PAUL
WHITECOURT
River
Lac Ste Anne
Sturgeon
Chip Lake
RIVER
EDSON
EDMONTON
Athabasca
McLeod
River
LLOYDMINSTER
DRAYTON VALLEY
SASKATCHEWAN
Pembina
WETASKIWIN
CAMROSE
Pigeon Lake
River
JASPER
Battle
WAINWRIGHT
NORTH
RED DEER
CORONATION
RED
SUNDRE
DEER
DRUMHELLER
BANFF
Bow
CALGARY
RIVER
River
BROOKS
SOUTH SASKATCHEWAN
CLARESHOLM
MEDICINE HAT
Oldman
River
LETHBRIDGE
St. Mary Res.
St. Mary R.
Milk
Pakowki Lake
CARDSTON
MONTANA
BRITISH COLUMBIA
ROCKY MOUNTAINS
SASKATCHEWAN

Alberta
ENVIRONMENT

KEY PLAN

FIG. 1



N
DOWNSTREAM LIMIT OF STUDY
CITY BOUNDARY
ST. ALBERT
WOODLANDS
LACOMBE PARK
MISSION PARK
FOREST LAWN
PINE VIEW
CAMPBELL INDUSTRIAL PARK
AKINSDALE
GRANDIN PARK
STURGEON RIVER
CITY BOUNDARY
UPSTREAM LIMIT OF STUDY
BIG LAKE
NORTHWEST SPORTS CENTRE
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TP53 R25 W4

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Alberta ENVIRONMENT

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ST. ALBERT FLOODPLAIN STUDY

STUDY REACH

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FIGURE No. 2

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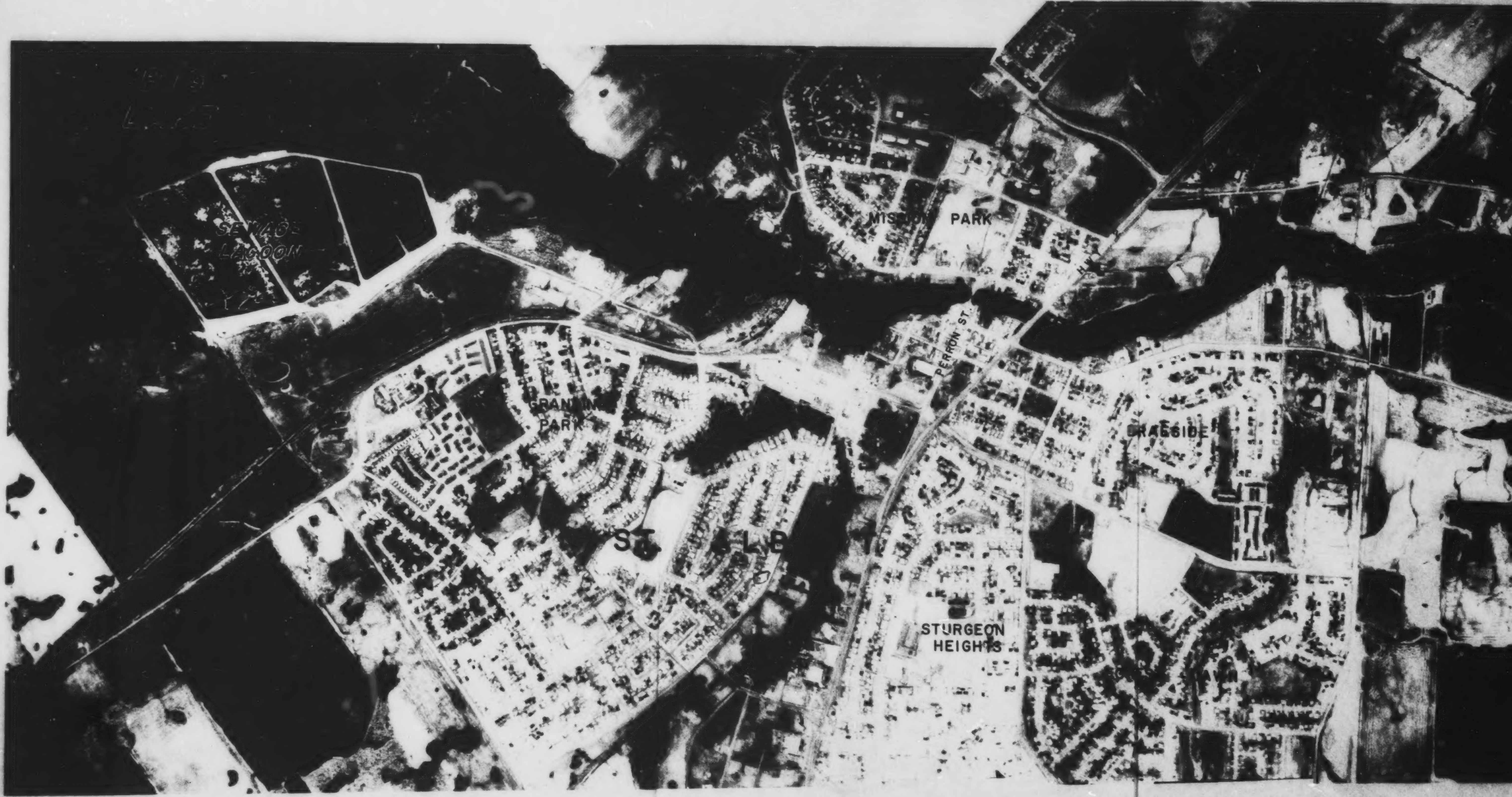
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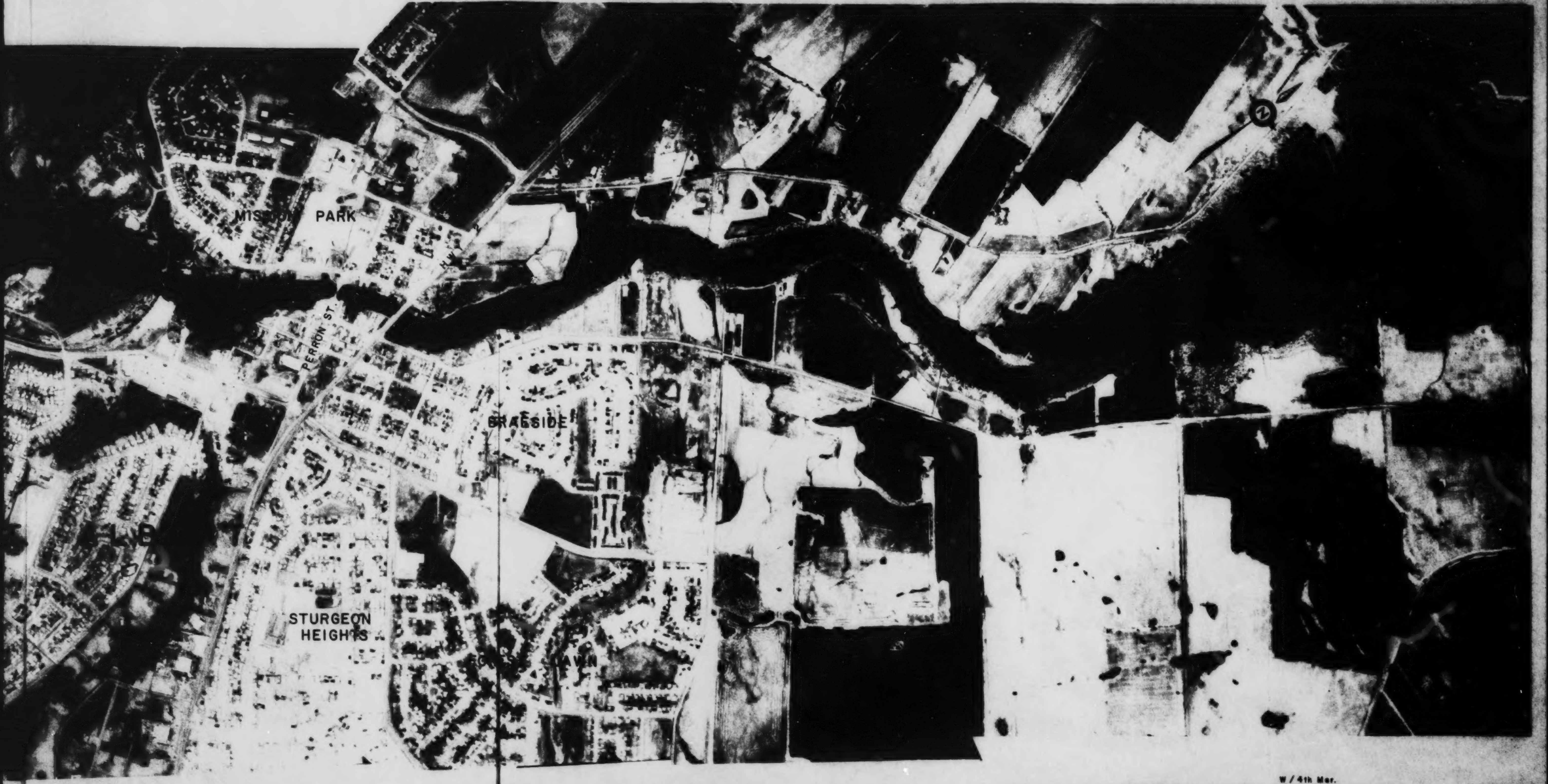
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RIVER ENGINEERING
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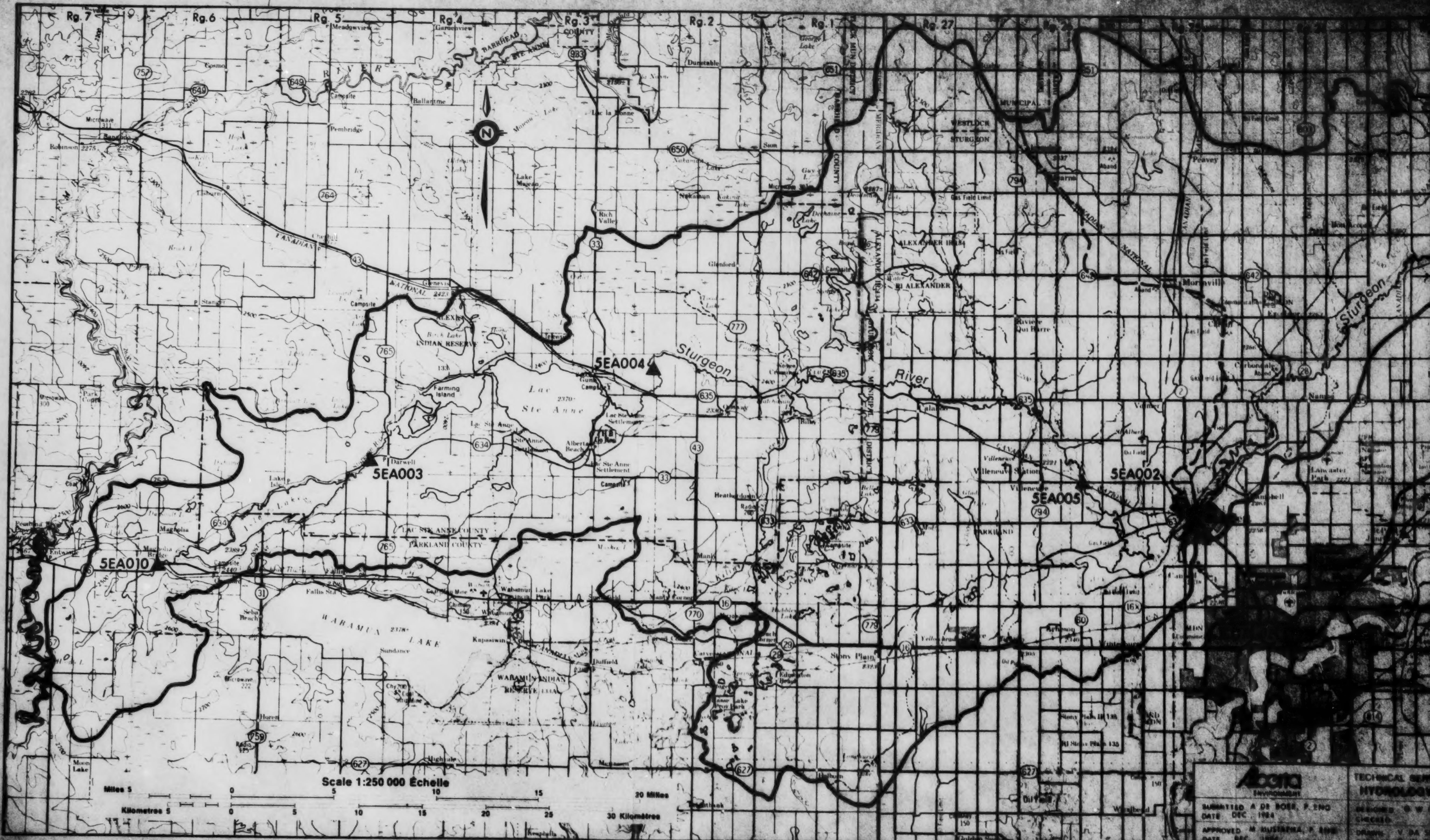
ST. ALBERT FLOODPLAIN STUDY

1974 FLOOD MOSAIC
STURGEON RIVER AT ST.ALBERT

FIGURE No. 3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Rg. 6
Rg. 5
Rg. 4
Rg. 3
Rg. 2
Rg. 1
Rg. 27
Meadowview
Gardenview
BARRHEAD
COUNTY
Cosmo
Campsite
Ballantine
Pembridge
Microwave
Robinson
Tiburn
Lac la Nonne
Dunstable
Sion
Nakamun
Rich Valley
Glenford
Genesis
Stanger
ALEXIS
INDIAN RESERVE
Lac Ste Anne
Farming Island
Darwell
Alberta Beach
Lac Ste Anne Settlement
Gunn
Sturgeon
River
Calahoo
Villeneuve
Villeneuve Station
Morinville
Riviere Qui Barre
ALEXANDER IR 134
WESTLOCK
STURGEON
Carbondale
Lancaster Park
Peavey
Cardiff
Namao
Magnolia
Magnolia Bridge
Entwistle
Fallis
Seba Beach
Wabamun
Lake Isle
WABAMUN LAKE
Kapasiwin
Duffield
Sundance
WABAMUN INDIAN RESERVE 133A
LAC STE ANNE COUNTY
PARKLAND COUNTY
Stony Plain
Spruce Grove
Heatherdown
Manly Corner
Acheson
Winterburn
Horen
Moon Lake
Highvale
Tomahawk
Keephills
Stony Plain IR 135
5EA004
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Scale 1:250 000 Échelle
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Alberta
ENVIRONMENT
SUBMITTED A DE BOER, P. ENG
DATE DEC. 1984
APPROVED M MUSTAPHA, P. ENG
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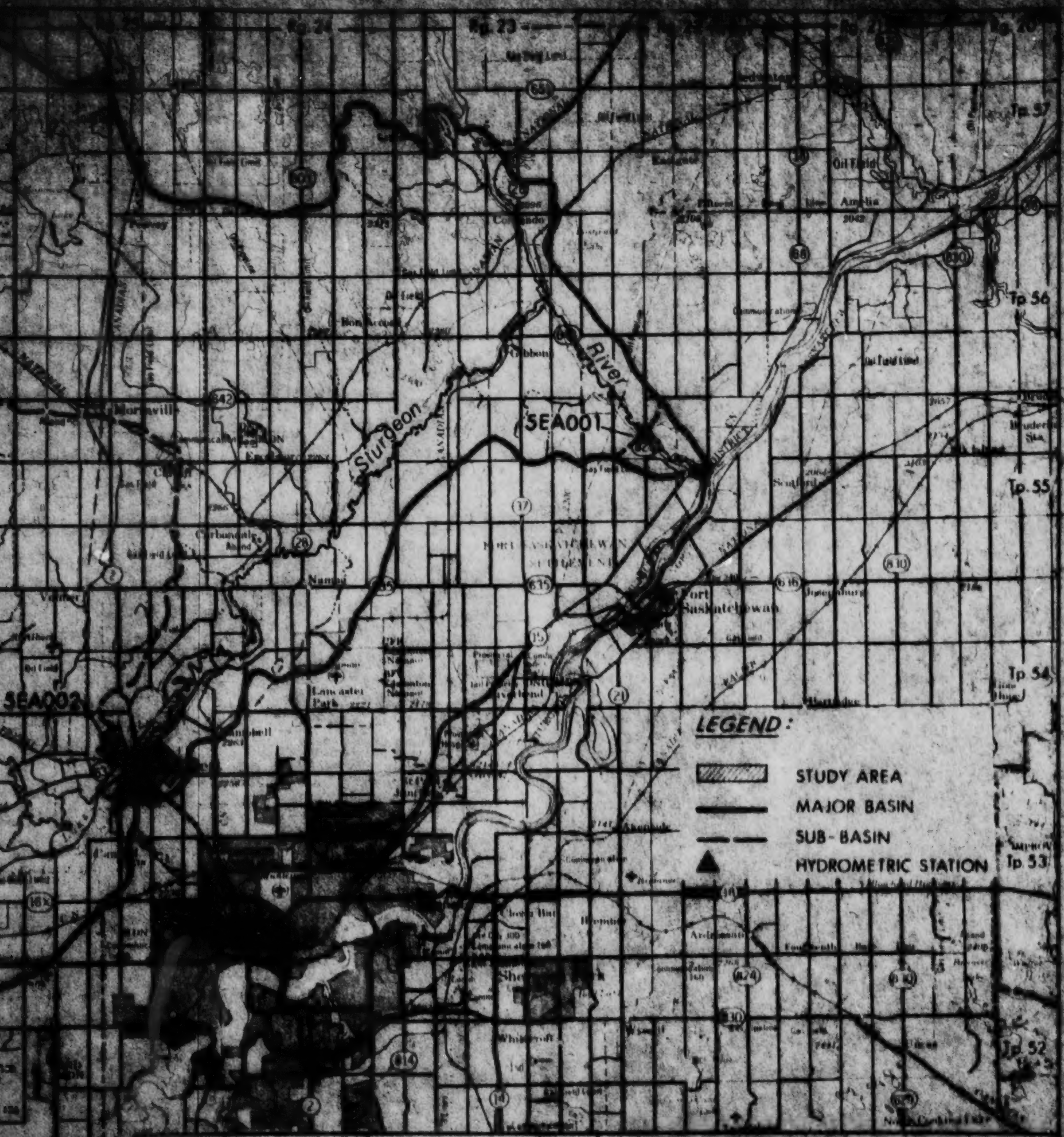
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River
5EA001
5EA002
Morinville
Gibbons
Bon Accord
Fort Saskatchewan
Lancaster Park
Namao
Amelia
Legal
Villeneuve
Sherwood Park
FORT SASKATCHEWAN SETTLEMENT
LEGEND:
▨ STUDY AREA
MAJOR BASIN
SUB-BASIN
▲ HYDROMETRIC STATION

Alberta
ENVIRONMENT

SUBMITTED A. DE BOER, P. ENG.
DATE DEC. 1984
APPROVED [illegible], P. ENG.
DATE DEC. 1984

TECHNICAL SERVICES DIVISION
HYDROLOGY BRANCH

DESIGNED G. W. GUENTHER
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DRAWN V. DA SILVA, [illegible]
CHECKED G. W. GUENTHER

ST. ALBERT FLOODPLAIN STUDY

STURGEON RIVER DRAINAGE BASIN

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FIGURE No. 4

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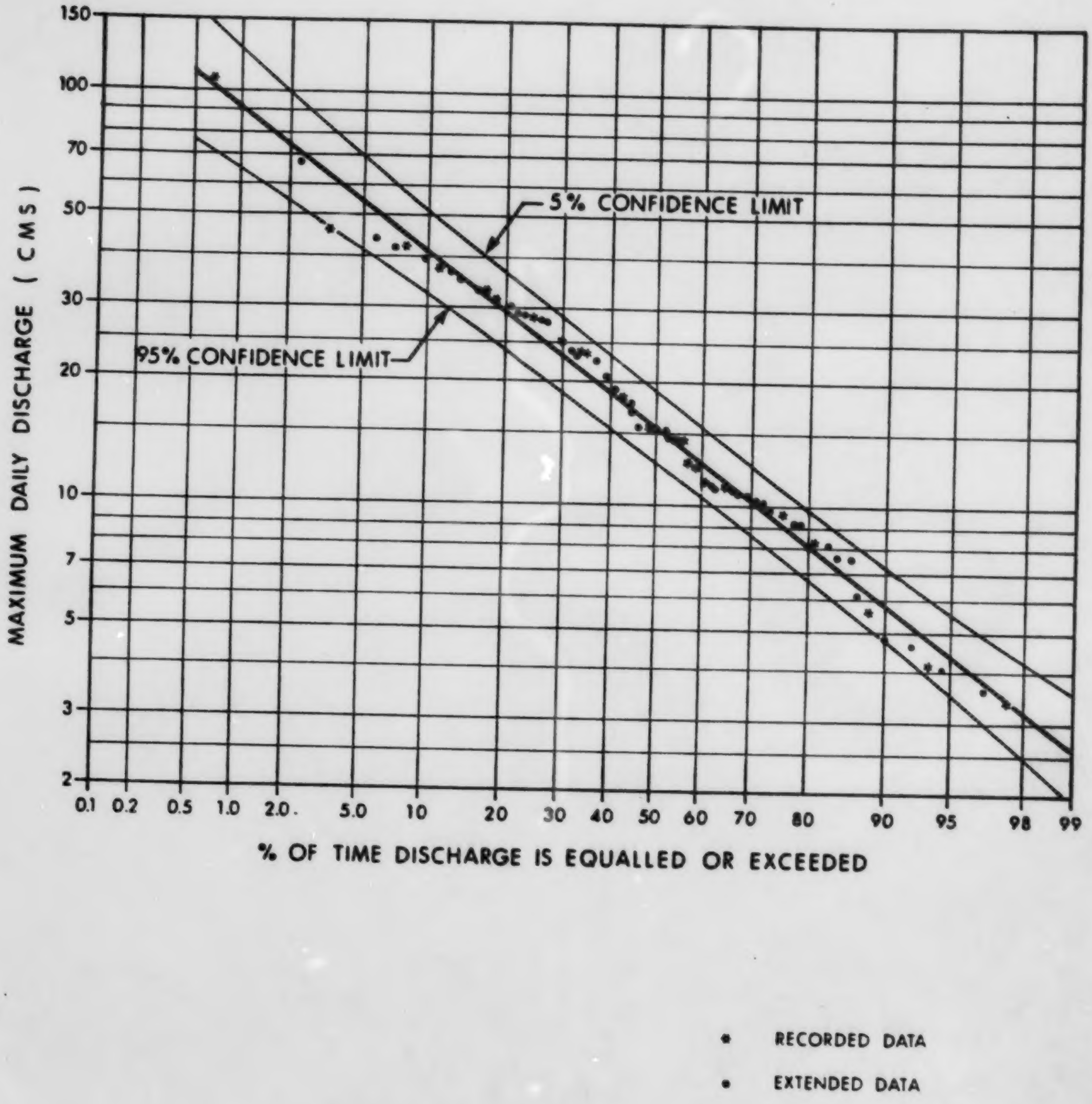

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	FLOOD FREQUENCY CURVE STURGEON RIVER AT ST. ALBERT
SUBMITTED A DE BOER, P ENG DATE NOV, 1984	DESIGNED G W GUENTHER CHECKED	
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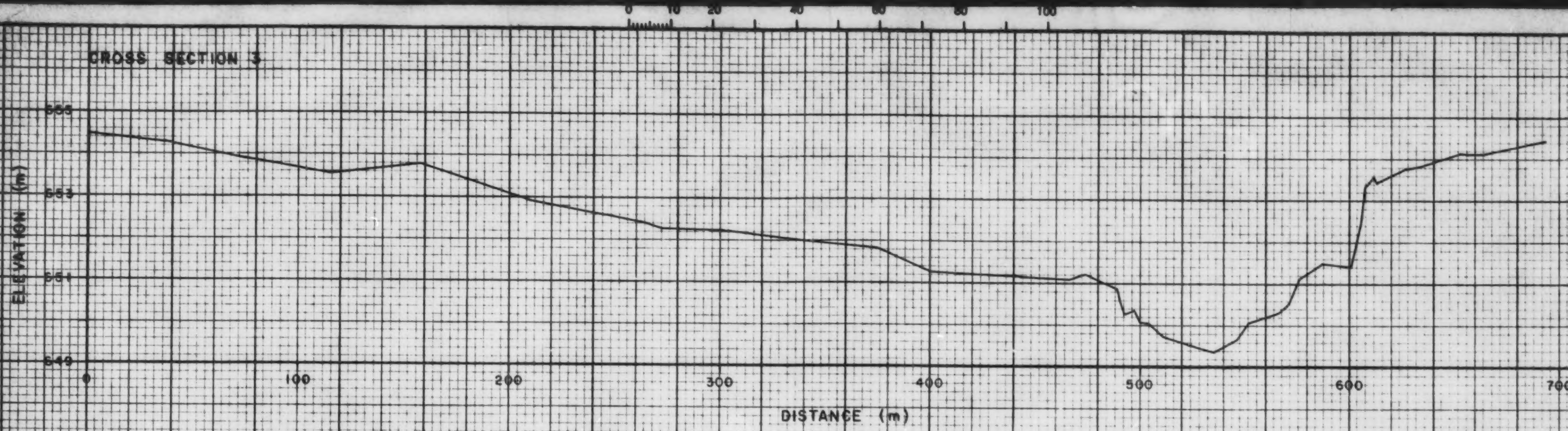

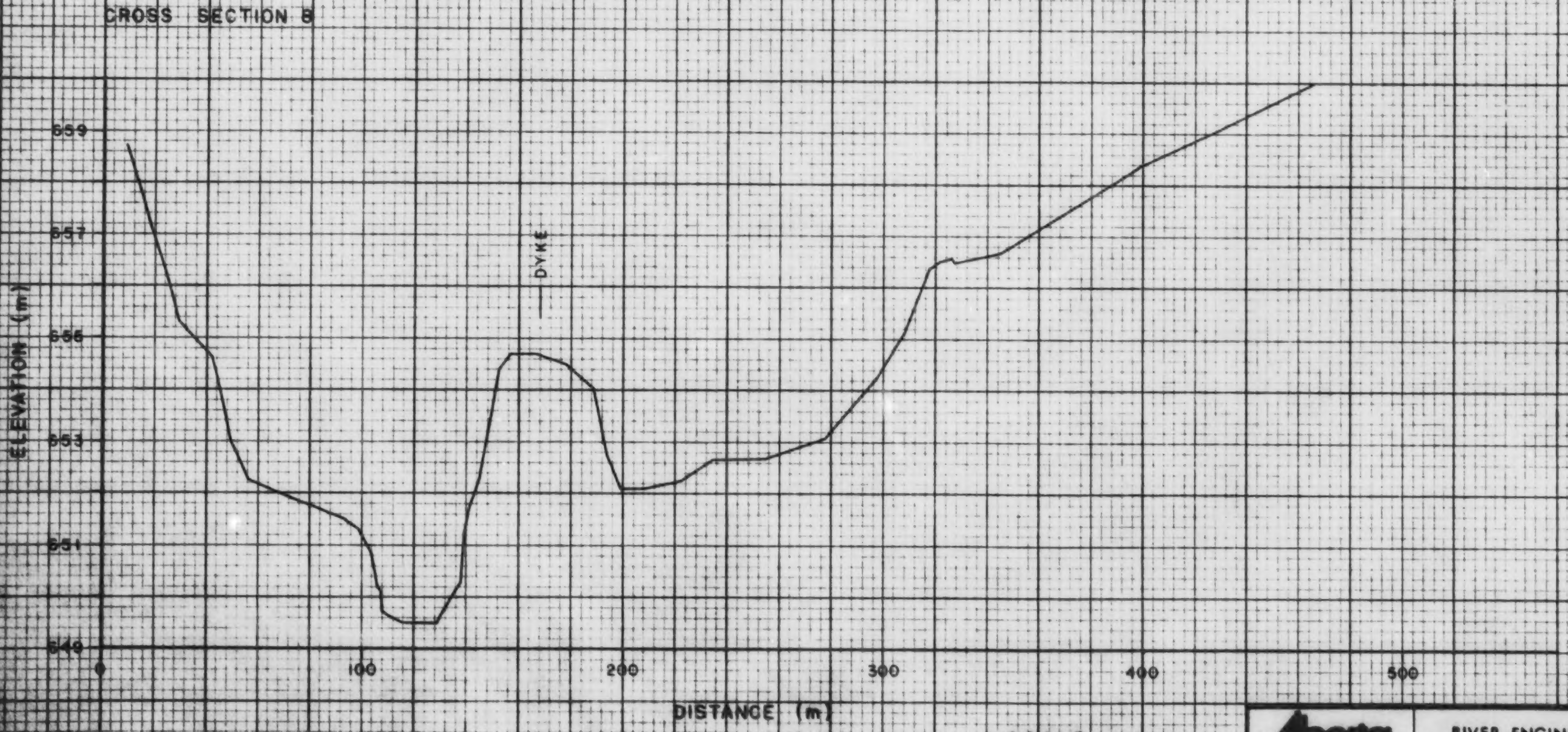

NOTE: FOR CROSS SECTION LOCATIONS, SEE FIGURE 9C

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HORIZ 1:2000
VERT 1:100

Alberta ENVIRONMENT	RIVER ENGINEERING BRANCH	ST. ALBERT FLOODPLAIN STUDY
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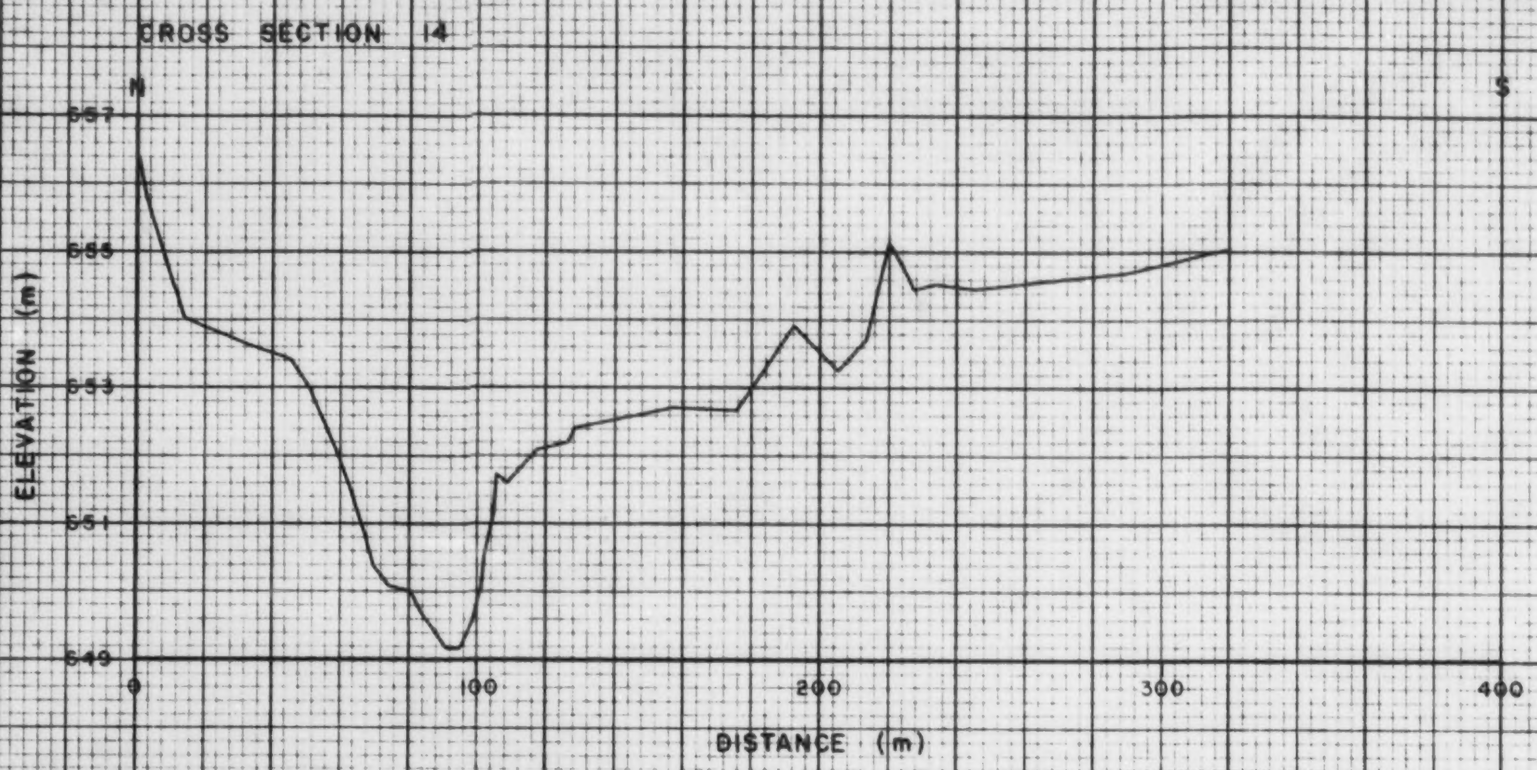
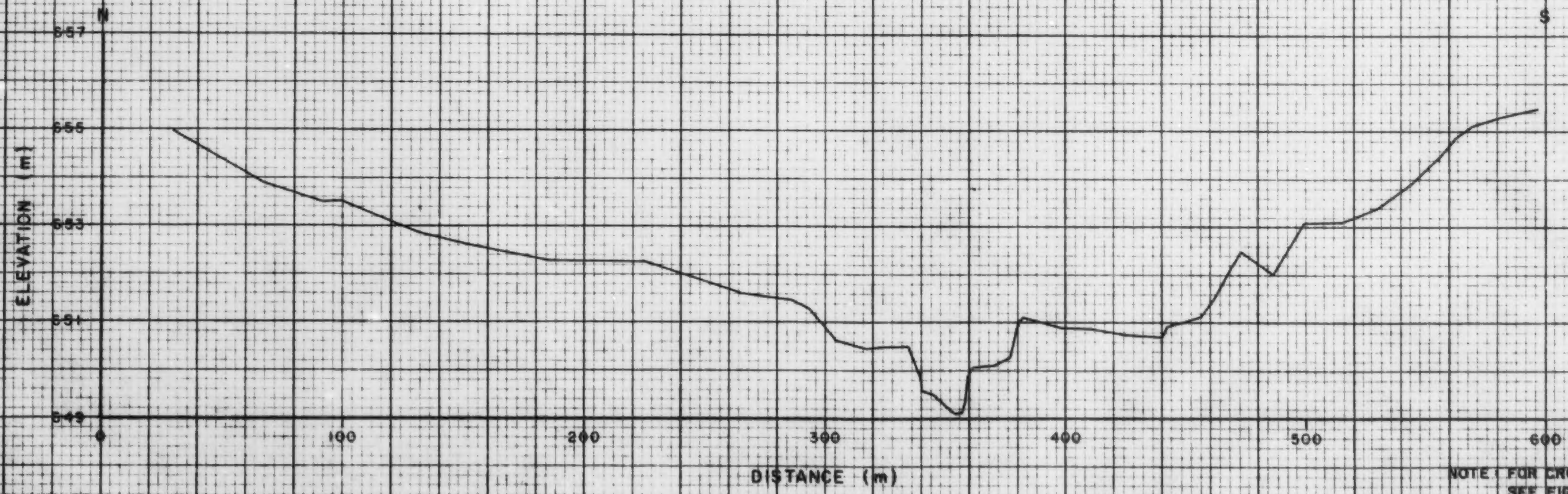
CHECKED	SHEET 1 OF 2	FIGURE No. 6A

CROSS SECTION 14



CROSS SECTION 21



NOTE : FOR CROSS SECTION LOCATIONS
SEE FIGURE 9D

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ST. ALBERT FLOODPLAIN STUDY

TYPICAL CROSS SECTIONS

FIGURE No. 6B

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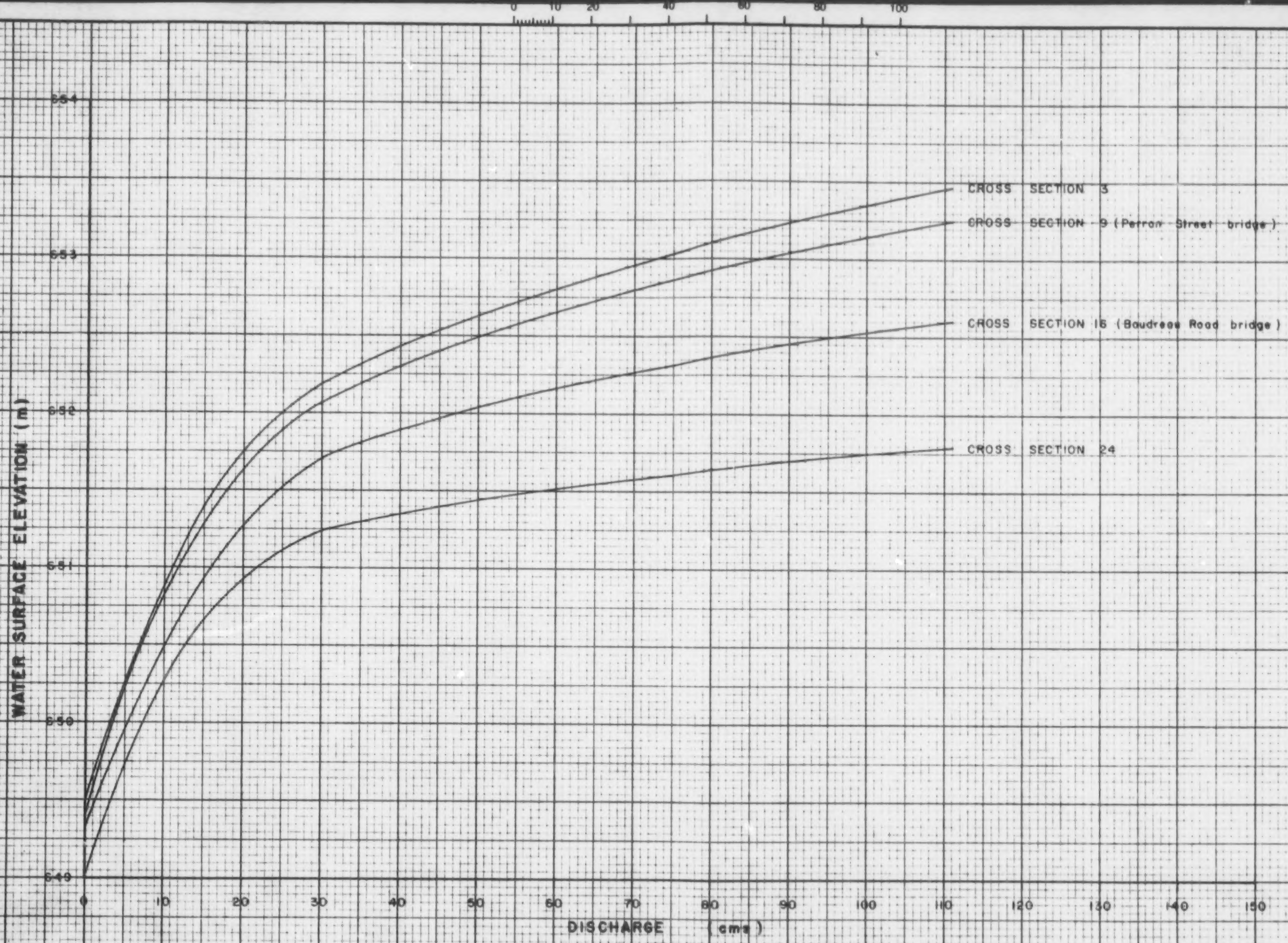

Alberta ENVIRONMENT	RIVER ENGINEERING BRANCH	ST. ALBERT FLOODPLAIN STUDY STAGE - DISCHARGE CURVES
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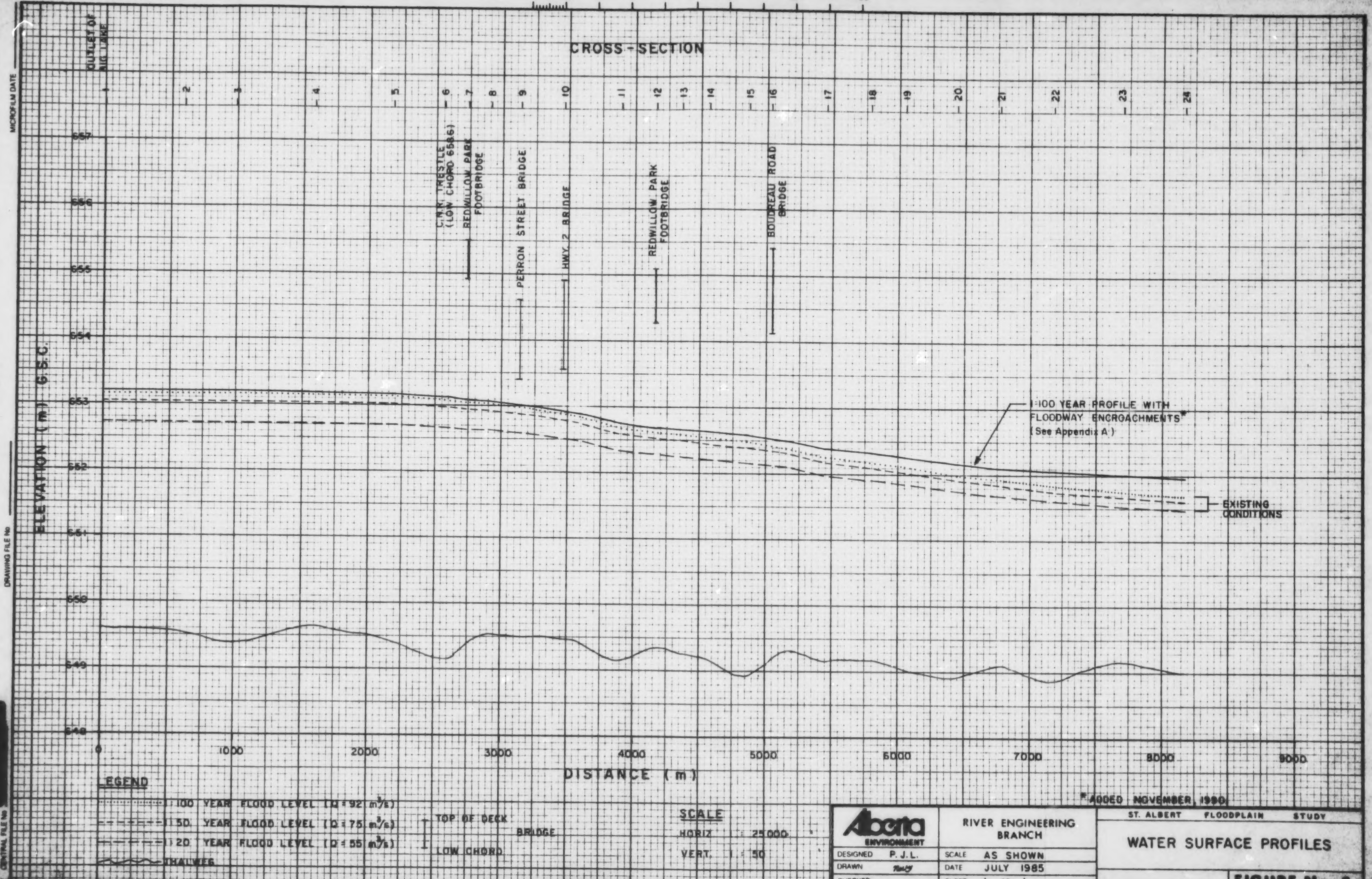

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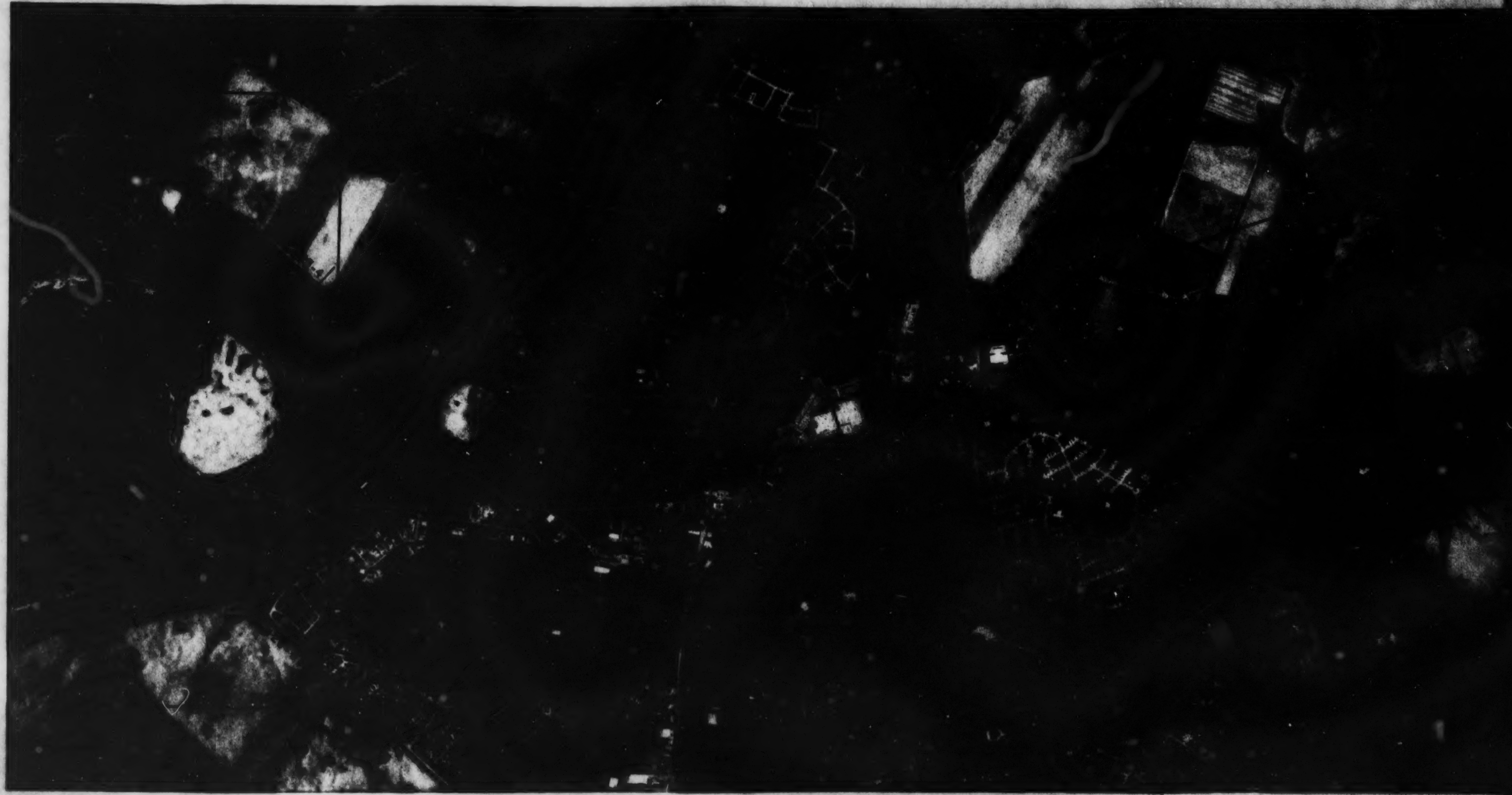

AERIAL PHOTOGRAPHY SEPT. 1, 1983

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LOCATION OF FLOODPLAIN DELINEATION MAPS

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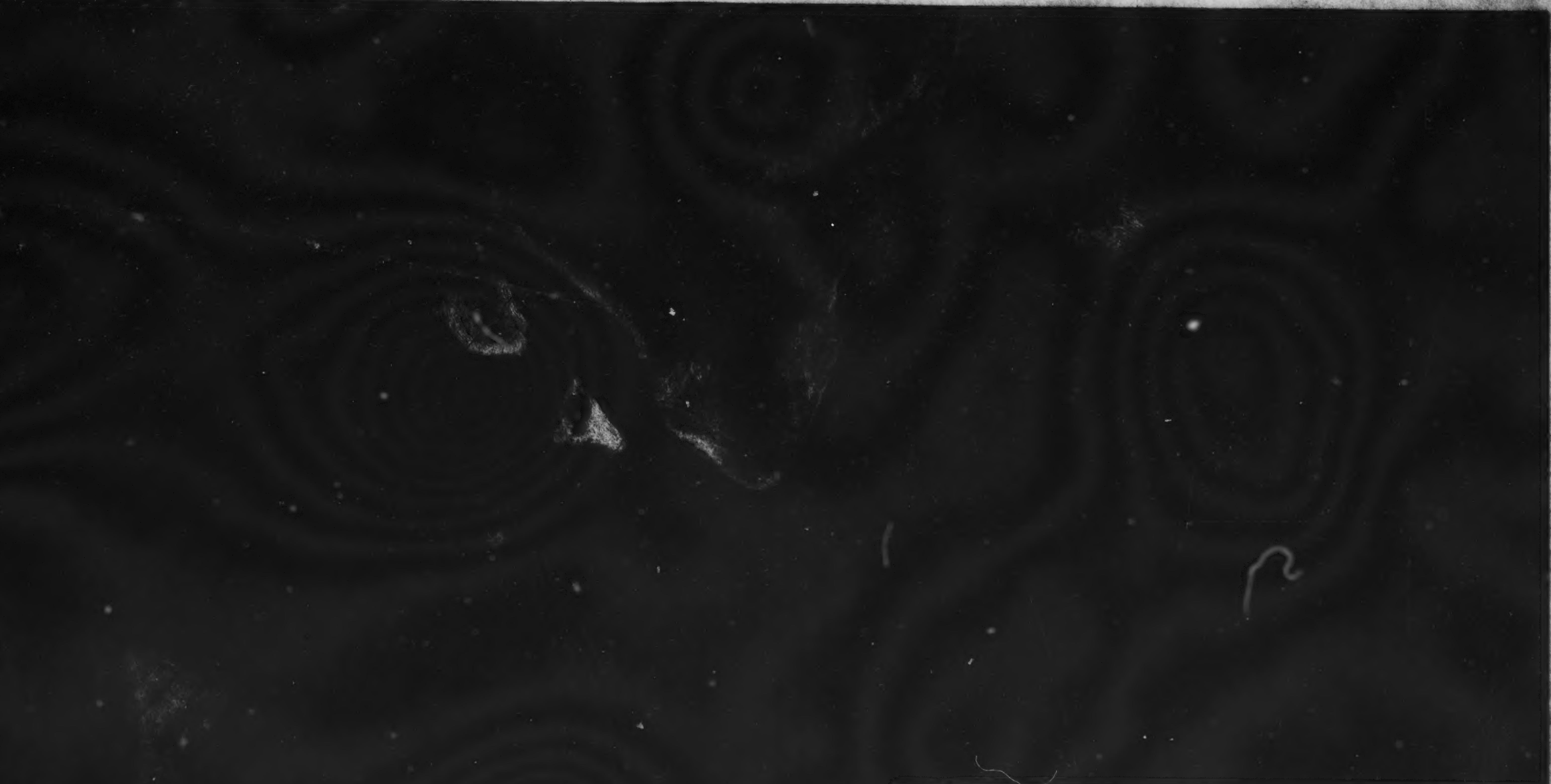
FIGURE No. 9A



③ CROSS SECTION LOCATION

——— 1:100 YEAR FLOOD

– – – – 1:50 YEAR FLOOD

······· 1:20 YEAR FLOOD

Alberta ENVIRONMENT

RIVER ENGINEERING BRANCH

ST. ALBERT FLOODPLAIN STUDY

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DRAWN E.B.

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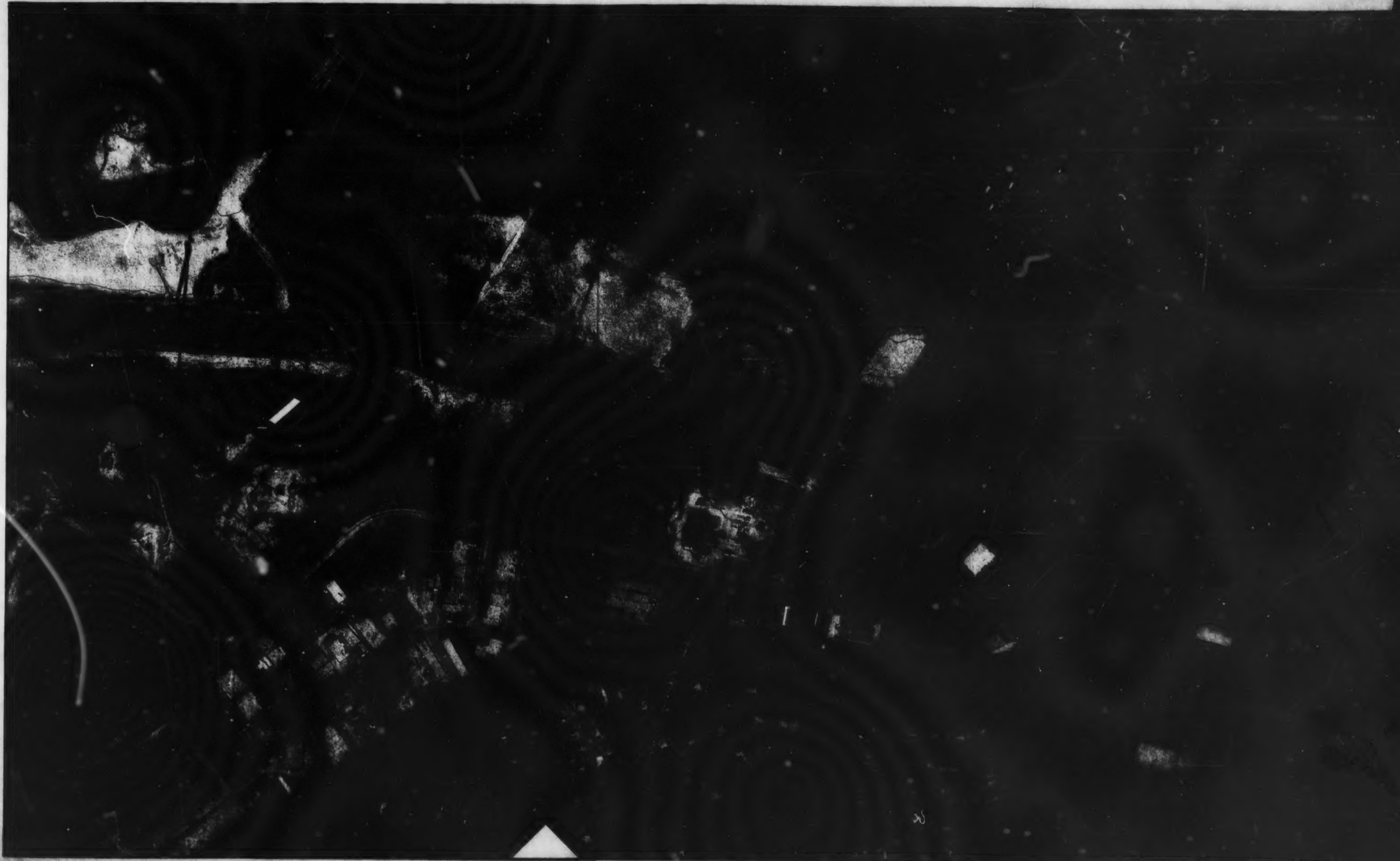
SHEET 2 OF 4

FIGURE No. [illegible]



③ CROSS SECTION LOCATION

——— 1:100 YEAR FLOOD

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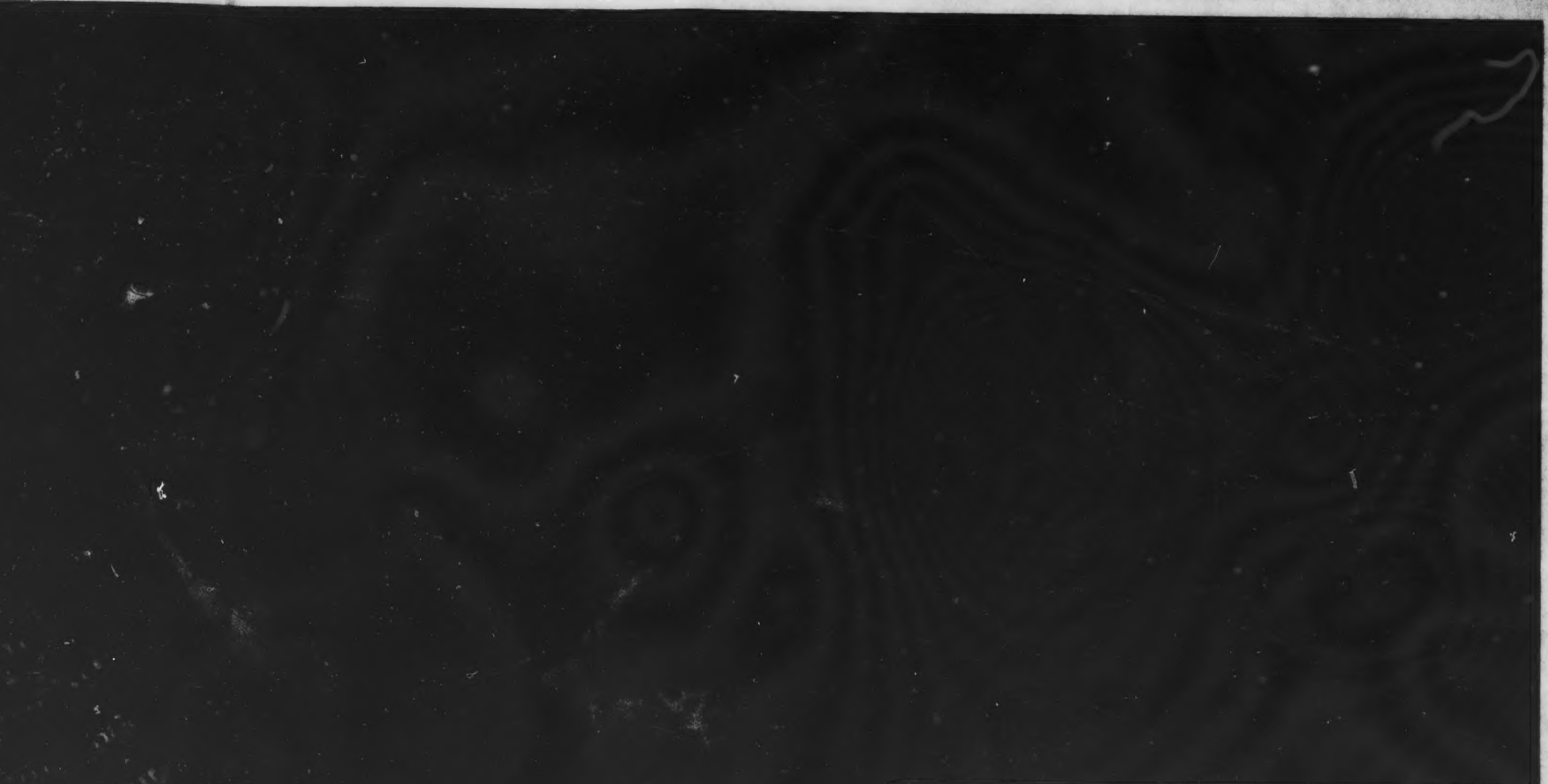

③ CROSS SECTION LOCATION

—— 1:100 YEAR FLOOD

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APPENDIX A

TWO - ZONE FLOOD RISK MAPPING

This appendix contains the revised (two-zone) flood risk maps for St. Albert as well as a description of the additional hydraulic analysis and computer modelling upon which the maps are based.

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1.0 TERMINOLOGY

The following terminology has been adopted by the Technical Committee, Canada - Alberta Flood Damage Reduction Program (FDRP).

1.1 Flood Risk Area

The flood risk area is the area which would be inundated by the design flood. In Alberta the adopted design flood is the so called 1:100 year flood which is an extreme event having a one percent chance of being equalled or exceeded in any year.

The flood risk area includes the floodway and the flood fringe. These two terms are defined below.

1.2 Floodway

The floodway is that portion of the flood risk area where the flood waters are deepest, fastest and most destructive. It is a constricted channel area within which the entire design flood can be conveyed without raising water levels or increasing flow velocities beyond specified limits.

The criteria used to determine the physical limits of the floodway are described in the following Section 2.1.

1.3 Flood Fringe

The flood fringe is the outer portion of the flood risk area. The water in this zone is shallower and flows more slowly than in the floodway. Conditions are generally less hazardous than in the floodway.

1.4 Designation

As flood risk maps are completed, the federal and provincial Ministers reponsible for the FDRP will designate the flood risk area as a zone wherein certain government policies will apply.

2.0 FLOODWAY DETERMINATION

2.1 Hydraulic Criteria

Under the FDRP, the following hydraulic criteria have been adopted for determining floodway limits:

1. The water surface profile shall not exceed 0.3 m (or less as specified by the Technical Committee for Canada-Alberta FDRP) above the profile for the design flood under existing floodplain conditions.

2. In general, all areas where the depth of flooding exceeds 1 m or the velocities are above 1 m/s, shall become a part of the floodway. However, in order to achieve a hydraulically smooth floodway boundary, some areas with depths exceeding 1 m and velocities exceeding 1 m/s will inevitably become part of the flood fringe.

3. In river reaches where the existing mean channel velocities are excessive, the encroachments for floodway should be minimized so that the existing velocities are not further increased.

4. In reaches of supercritical flow no encroachment shall be introduced.

5. In the case of ice jam flooding, areas with depths of flooding of 1 m of more shall become a part of the floodway.

These criteria are intended to limit the flood hazard in the flood fringe and to minimize increases in upstream water levels. They are generally referred to as the depth-velocity-rise criteria.

2.2 Methodology

The depth-velocity-rise criteria discussed in the previous Section was used where appropriate to define the limits of the Sturgeon River floodway in the study area. The application of these criteria involved the following steps:

Step 1 Define the floodway limits according to the depth criterion.

Step 2 Modify the HEC-2 computer model developed in the 1986 Floodplain Study (using Floodway Encroachment Method 1) and model the proposed floodway in Step 1.

Step 3 Compute the water surface profile for the 1:100 year (design) flood with floodway encroachments.

Step 4 Check the velocity criterion using the Flow Distribution Option in the HEC-2 program.

Step 5 Check the rise criterion by comparing computed water levels with and without floodway encroachments.

Step 6 If necessary, repeat steps 3-5 with an expanded floodway (successive trials) until the velocity and rise criteria are satisfied at each cross-section.

Step 7 Check the 1 m depth criterion to ensure that the floodway assumed in Setp 1 is still acceptable.

The above approach was not used in the reach through the existing built up portion of St. Albert (i.e., between the CNR crossing in the west and Boudreau Road in the east). The floodplain in this area has already been encroached upon by various developments which have constricted flows through the use of landfill and extensive dyking systems. It was generally felt that any further narrowing of the floodway in this reach would be unacceptable.

2.3 Computed Profiles

The computed water surface profile for the 1:100 year design flood with floodway encroachments (final configuration) is presented in Figure 8 (main report) along with the profile computed for natural (existing) conditions. As can be seen, these two profiles are very similar (i.e., less than 0.1 m difference) accept for the lower end of the study reach (Cross-Sections 15-24) where the levels computed for floodway conditions are slightly higher. In this reach, the floodway is defined by the 0.3 m rise criterion, whereas in the upper reach (below Big Lake), it is defined by the depth criterion.

Table A-1 contains a listing of the computed water surface elevations corresponding to the profiles shown in Figure 8. Computer output for the final 1:100 year model runs are included in Appendix D.

2.4 Flood Risk Maps

The resultant two-zone flood risk maps for St. Albert are presented on Sheets 1 & 2 contained in this Appendix. A brief description of the areas affected by the floodway/flood fringe designation follows.

Upper Reach (Big Lake to CNR Crossing)

The natural floodplain in this reach is for the most part undeveloped. This is particularly true of the north side of the channel which consists of predominantly cultivated land with some forested areas. On the south side of the river, light industrial activity exists along Riel Drive just upstream of the CNR crossing; however, this development lies just outside the 1:100 year flood limits as does the race track facility farther to the west. The city's sewage lagoon is constructed on low ground adjacent to the outlet of Big Lake, however, it is surrounded by a high perimeter dyke.

The floodway proposed for this reach is generally defined by the one-metre depth criterion. No development currently exists inside the floodway limits.

Central Reach (CNR Crossing to Boudreau Road)

The natural floodplain in this reach is generally much narrower than that in the reach immediately below Big Lake. In addition, flows have been further confined by development activity (landfill) on both sides of the river and by the construction of a dyke which runs along the south bank between the CNR grade and the St. Albert Trail.

As mentioned previously, it was felt that any further constriction of flows in this reach would, in general, be unacceptable. Therefore most of the area within the 1:100 year flood limits has been designated as floodway. Exceptions to this include:

1. a shallow backwater area located just to the west of St. Albert Place (Sheet 1)

    - this area lies behind an existing dyke, however a low section around the end of the embankment adjacent to the CNR grade will allow water to escape and pond in the shallow depression south of the channel

2. small backwater zones located immediately upstream and downstream of bridge approaches
3. a somewhat wider section of floodplain located on the south side of the river just upstream of Boudreau Road (between cross sections 14 & 15)

The above areas have been designated as flood fringe.

Downstream Reach (Below Boudreau Road)

The natural floodplain in this reach has not been encroached upon by urban development. The floodway has been designated using the criteria discussed previously.

TABLE A-1

Computed Water Surface Elevations

X-Section Number	COMPUTED WATER SURFACE ELEVATION (m)				h[2] (m)
	1:20 Year Flood	1:50 Year Flood	1:100 Year Flood		
			Existing	Floodway[1]	
1	652.73	653.04	653.16	653.20	.04
2	652.73	653.04	653.16	653.20	.04
3	652.72	653.03	653.16	653.20	.04
4	652.72	653.03	653.15	653.19	.04
5	652.71	653.02	653.14	653.18	.04
6.3	652.70	652.97	653.08	653.12	.04
6.4	652.70	652.97	653.08	653.12	.04
7	652.64	652.94	653.04	653.09	.05
8	652.63	652.92	653.03	653.08	.05
9.3	652.57	652.86	652.95	653.00	.05
9.4	652.57	652.85	652.94	652.99	.05
10.3	652.48	652.75	652.83	652.89	.06
10.4	652.47	652.73	652.81	652.87	.06
11	652.34	652.59	652.68	652.75	.07
12.2	652.28	652.53	652.61	652.69	.08
12.3	652.28	652.52	652.61	652.69	.08
13	652.25	652.50	652.59	652.67	.08
14	652.22	652.45	652.54	652.63	.09
15	652.17	652.40	652.49	652.59	.10
16.3	652.11	652.32	652.39	652.50	.11
16.4	652.09	652.31	652.38	652.49	.11
17	651.98	652.18	652.26	652.39	.13
18	651.91	652.10	652.18	652.32	.14
19	651.85	652.03	652.11	652.26	.15
20	651.75	651.91	651.99	652.17	.18
21	651.69	651.84	651.92	652.13	.21
22	651.61	651.75	651.81	652.06	.25
23	651.53	651.67	651.74	652.01	.26
24	651.48	651.61	651.68	651.97	.29

---

[1] Flow constricted to floodway

[2] Difference between 1:100 year water levels with and without floodway.

APPENDIX B

FLOOD FREQUENCY ANALYSIS

This appendix contains the report, "Flood Frequency Analysis - St. Albert Floodplain Study" prepared by the Hydrology Branch, Alberta Environment, January, 1985.

WATER RESOURCES MANAGEMENT SERVICES

TECHNICAL SERVICES DIVISION

HYDROLOGY BRANCH

FLOOD FREQUENCY ANALYSIS
ST. ALBERT FLOODPLAIN STUDY

Submitted by: A.M. Mustapha, P. Eng.
Hydrology Branch Head

Prepared by: G. W. Guenther
Hydrology Technologist

JANUARY, 1985

January 15, 1985

M. E. Quazi, P. Eng.
Branch Head
River Engineering Branch
Technical Services Division
Alberta Environment

Dear Mr. Quazi:

We have the pleasure of submitting to you the updated version of the report entitled, "Flood Frequency Analysis - St. Albert Floodplain Study", which is in accordance with your request of September 11, 1984. The report was prepared to provide input toward an assessment of the extent of mapping required to delineate floodplain boundaries within the study area. Flood frequency estimates based on the most current available information have been provided in this updated version of the report.

The report provides hydrological analyses detailing the magnitude of flood flows at the City of St. Albert.

This report has been prepared by G. W. Guenther and has been reviewed by A. DeBoer, P. Eng. and R. A. Bothe, P. Eng.

Yours truly,

A. M. Mustapha, P. Eng.
BRANCH HEAD
Hydrology Branch

GWG/sr

Enclosure

SYNOPSIS

This report presents details of the flood frequency analysis of the Sturgeon River at St. Albert. The study involves the examination of the annual flood series, the extension of the Sturgeon River at St. Albert hydrometric data base, and the selection of a representative frequency distribution. The 1:100 year return period flood estimate for the Sturgeon River at St. Albert is 92 cubic meters per second.

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1. INTRODUCTION

1.1 Study Area Elements

The Sturgeon River originates approximately 90 kilometers west of the City of St. Albert. It flows in a general easterly direction through four major lakes: Isle Lake, Lac St. Anne, Matchayaw Lake, and Big Lake, to St. Albert. From St. Albert the Sturgeon River flows in a north-easterly direction to the Town of Fort Saskatchewan, where it enters the North Saskatchewan River. The elevations range from approximately 823 meters in the headwaters down to 610 meters at the mouth, an estimated drop of 213 meters.

The St. Albert Floodplain Study, depicted in Figure 1.1, extends from the outlet of Big Lake downstream through the City of St. Albert. The Sturgeon River at St. Albert drains an area of approximately 2650 square kilometers.

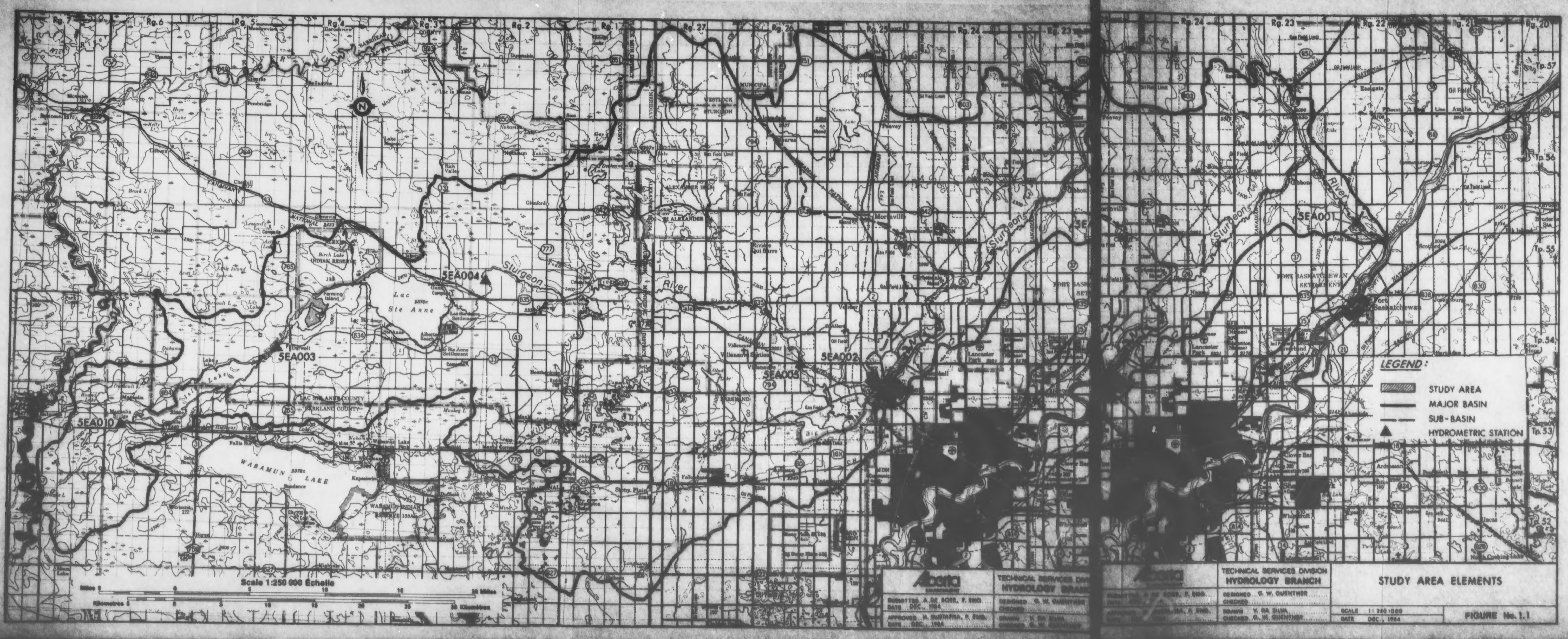
Flood frequency estimates for the Sturgeon River are presented for the delineation of the floodplain boundaries throughout the study area. This study determines the flood frequency estimates for the St. Albert Floodplain Study.

1.2 Related Studies

In August 1975, delineation of floodplain boundaries for the Sturgeon River through the City of St. Albert was completed by Alberta Environment (Szabon, 1975). The recent extension of the City boundaries and the addition of ten years of surface water runoff data necessitates the need for the present study.

1.3 Scope of the Study

This study determines the flood frequency estimates for the Sturgeon River at St. Albert. The hydrometric data was extended from 23 years of record to 65 years of record, based on the correlation between the Sturgeon River at St. Albert and the Sturgeon River at Fort Saskatchewan.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STUDY AREA
MAJOR BASIN
SUB-BASIN
HYDROMETRIC STATION
5EA001
5EA002
5EA003
5EA004
5EA005
5EA010
Sturgeon River
Lac Ste Anne
Wabamun Lake
Fort Saskatchewan
Morinville
Alexander
Villeneuve
Lancaster Park
Birch Lake Indian Reserve
Wabamun Indian Reserve
Lac Ste Anne County
Parkland County
Westlock
Sturgeon
Rg. 7
Rg. 6
Rg. 5
Rg. 4
Rg. 3
Rg. 2
Rg. 1
Rg. 27
Rg. 26
Rg. 25
Rg. 24
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Alberta ENVIRONMENT
SUBMITTED A. DE BOER, P. ENG.
DATE DEC., 1984
APPROVED M. MUSTAPHA, P. ENG.
DATE DEC., 1984
TECHNICAL SERVICES DIVISION
HYDROLOGY BRANCH
DESIGNED G. W. GUENTHER
CHECKED
DRAWN V. DA SILVA
CHECKED G. W. GUENTHER
SCALE 1: 250 000
DATE DEC., 1984

STUDY AREA ELEMENTS

FIGURE No. 1.1

2. STURGEON RIVER AT ST. ALBERT

2.1 Hydrometric Data

The Water Survey of Canada (WSC) hydrometric station 05AE002 - Sturgeon River at St. Albert has 23 years of recorded data, from 1914 to 1919, 1921 to 1927, 1971, 1974, and 1976 to 1983. The recorded flows for the 1971 and 1974 flood events were provided by the Water Survey Section of Alberta Environment. The 1974 flood event measured 104 cubic meters per second (cms) and is the highest recorded flood event on record. Table 2.1 (a) lists the maximum daily discharges for the Sturgeon River at St. Albert station. Since the recorded data for the Sturgeon River at St. Albert station are not continuous, and therefore would not provide reliable estimates of the flood magnitudes, another hydrometric station was required to extend the data base.

The only other long-term WSC hydrometric station in the Sturgeon River basin is station - 05AE001 - Sturgeon River near Fort Saskatchewan, which has 61 years of recorded data, from 1914 to 1923, 1929 to 1930, and 1935 to 1983. This station was chosen to extend the Sturgeon River at St. Albert data base, not only because of the length of record, but also because the recorded peak flows consist primarily of runoff generated upstream of St. Albert and indicated a high correlation between the peak flow rates at St. Albert and Fort Saskatchewan. Table 2.1 (b) lists the maximum daily discharges for the Sturgeon River near Fort Saskatchewan station.

2.2 Data Extension

Based on Section 2.1, the peak discharges for the Sturgeon River at St. Albert and the Sturgeon River near Fort Saskatchewan for the 19 years of corresponding observations, as listed in Table 2.1 (c), were analyzed using a linear regression by method of least squares. The relationship, in cms units, is given in equation 2.1.

TABLE 2.1 (a)
STURGEON RIVER AT ST. ALBERT
MAXIMUM DAILY DISCHARGES

Year	Maximum Daily Discharge (cms)	Year	Maximum Daily Discharge (cms)
1914	42.2	1927	30.9
1915	27.2	1971	45.5
1916	15.5	1974	104.0
1917	25.0	1976	13.3
1918	12.3	1977	9.49
1919	8.21	1978	13.1
1921	14.7	1979	17.9
1922	3.45	1980	14.7
1923	3.11	1981	23.3
1924	4.05	1982	32.9
1925	37.4	1983	11.9
1926	5.64		

TABLE 2.1 (b)
STURGEON RIVER NEAR FORT SASKATCHEWAN
MAXIMUM DAILY DISCHARGES

Year	Maximum Daily Discharge (cms)	Year	Maximum Daily Discharge (cms)
1914	51.8	1954	28.9
1915	30.6	1955	18.3
1916	17.0	1956	51.3
1917	31.4	1957	14.0
1918	16.4	1958	42.2
1919	10.8	1959	13.5
1920	28.9	1960	14.1
1921	17.0	1961	18.9
1922	3.82	1962	25.2
1923	3.20	1963	17.6
1929	8.69	1964	10.6
1930	4.36	1965	37.1
1935	32.8	1966	36.8
1936	58.0	1967	22.4
1937	9.23	1968	8.52
1938	20.3	1969	18.4
1939	5.24	1970	27.3
1940	47.3	1971	51.0
1941	12.8	1972	44.5
1942	3.99	1973	12.1
1943	54.4	1974	115.0
1944	38.5	1975	21.1
1945	5.47	1976	13.5
1946	13.7	1977	21.7
1947	10.5	1978	21.0
1948	89.8	1979	32.3
1949	13.6	1980	16.7
1950	6.74	1981	29.5
1951	11.4	1982	42.1
1952	29.4	1983	17.7
1953	33.4		

TABLE 2.1 (c)
RECORDED PEAK FLOWS FROM COINCIDENT EVENTS FOR STURGEON RIVER AT ST. ALBERT AND STURGEON RIVER AT FORT SASKATCHEWAN

St. Albert		Fort Saskatchewan	
Date	Recorded Flow (cms)	Date	Recorded Flow (cms)
1914 April 16	10.5	1914 April 16	10.8
1914 June 19	42.2	1914 June 21	51.5
1915 March 30	16.4	1915 April 3	24.7
1915 June 19	27.2	1915 June 23	30.6
1916 April 16	15.5	1916 April 18	17.0
1917 April 22	25.0	1917 April 24	31.4
1917 May 27	14.5	1917 May 28	16.7
1918 April 12	12.3	1918 April 14	16.4
1918 June 4	6.43	1918 June 4	5.69
1919 April 14	8.21	1919 April 15	10.8
1919 June 12	3.51	1919 June 13	3.74
1921 April 13	14.7	1921 April 13	17.0
1922 May 4	3.45	1922 May 4	3.34
1923 May 2	3.06	1923 May 4	3.20
1971 April	45.5	1971 April 28	51.0
1974 April 26	104.0	1974 April 27	115.0
1976 April 13	13.3	1976 April 14	12.8
1977 April 10	9.49	1977 April 10	21.7
1978 April 11	13.1	1978 April 11	21.0
1979 April 26	17.9	1979 April 28	21.3
1980 April 16	14.7	1980 April 17	16.2
1981 April 4	23.3	1981 April 6	27.3
1982 May 1	32.9	1982 May 3	36.7
1983 July 3	11.9	1983 July 5	14.8

$$Q_{SA} = 1.0196\ Q_{FS}^{0.93218} \qquad \text{.....Equation 2.1}$$

Where:

Q_{SA} = annual maximum daily flow at St. Albert.

Q_{FS} = annual maximum daily flow at Fort Saskatchewan.

The index of determination (r^2) of Equation 2.1 is 0.919. This implies that 91.9 percent of the variance in the maximum daily discharges is explained by the regression equation. The extended period of record for the Sturgeon River at St. Albert, based on the above analysis, are listed in Table 2.1 (d).

The 1974 flood on the Sturgeon River through St. Albert is the largest recorded flood in the 65 year period presented in Table 2.1 (b). An assessment of this flood event showed that the instantaneous peak was less than 1 percent greater than the mean daily peak flows. Since data limits the estimation of instantaneous flood flow rates and since floodplain delineation utilizes extreme flood events, the annual maximum daily flows are considered representative of the instantaneous flood flows for higher magnitude flood events.

TABLE 2.1 (d)

STURGEON RIVER AT ST. ALBERT MAXIMUM DAILY DISCHARGES

Year	Maximum Daily Discharge (cms)	Year	Maximum Daily Discharge (cms)
1914	42.2 *	1958	33.4
1915	27.2 *	1959	11.9
1916	15.5 *	1960	12.0
1917	25.0 *	1961	15.8
1918	12.3 *	1962	20.6
1919	8.21 *	1963	14.8
1920	23.5 *	1964	9.21
1921	14.7 *	1965	29.6
1922	3.45 *	1966	29.4
1923	3.11 *	1967	18.5
1924	4.05 *	1968	7.51
1925	37.4 *	1969	15.4
1926	5.64 *	1970	22.2
1927	30.9 *	1971	45.5 *
1929	7.65	1972	35.1
1930	4.02	1973	10.4
1935	26.4	1974	104.0 *
1936	44.9	1975	17.5
1937	8.09	1976	13.3 *
1938	16.9	1977	9.49 *
1939	4.78	1978	13.1 *
1940	37.1	1979	17.9 *
1941	11.0	1980	14.7 *
1942	3.70	1981	23.3 *
1943	42.3	1982	32.9 *
1944	30.6	1983	11.9 *
1945	4.97		
1946	11.7		
1947	9.13		
1948	67.5		
1949	11.6		
1950	6.04		
1951	9.85		
1952	23.8		
1953	26.8		
1954	23.5		
1955	15.3		
1956	40.0		
1957	11.9		

* Sturgeon River at St. Albert Recorded Data

3. FLOOD FREQUENCY DISTRIBUTION

The maximum daily discharges are a series of random events for which the population distribution is unknown. It is therefore necessary to associate a frequency distribution with these events in order to assign the flood probabilities. Since there are several statistical distributions that can be applied to the Sturgeon River data, two selection criteria were used to identify the appropriate distribution.

3.1 Selection Criteria

3.1.1 Probability Theory

The first selection criterion used is the probability theory. The probability theory makes it possible to interpret the statistical distribution results, since many statistical distribution procedures involve conclusions based on data samples which are affected by random variations. The probability theory can be represented by Equation 3.1.

$$P_{nr} = p^n q^{r-n} \left(\frac{r!}{(r-n)!n!}\right) \qquad \text{..... Equation 3.1}$$

Where: P_{nr} = the probability of a particular event being equalled or exceeded n times in a sample of r events.

p = 1/t where t is the return period of the event.

q = 1-p

The probability theory is limited to the period of record, with the assumption that a distribution that is representative of the existing period of record, will also apply to the extended period of record. This applies to the extended period of record for the Sturgeon River at St. Albert.

The probability of various return period events occurring for the Sturgeon River at St. Albert for the period of record are summarized in Table 3.1.1 (a). All the probabilities listed in the table are independent of distribution type and will be used to compare one distribution to another.

TABLE 3.1.1 (a)

PROBABILITY (%) OF THE EVENT OCCURRING n TIMES IN r YEARS
STURGEON RIVER AT ST. ALBERT n TIMES IN 65 YEARS

Number of	Flood Event Return Period (years)					
Events (n)	1:100	1:50	1:20	1:10	1:5	Remarks
0	52.0	26.9	3.6	0.1	0.0	
1	34.2	35.7	12.2	0.8	0.0	
2	11.0	23.3	20.5	2.7	0.0	
3	2.3	10.0	22.7	6.4	0.0	
4	0.4	3.2	18.5	11.0	0.1	
5	0.1	0.8	11.9	14.8	0.4	
6	0.0	0.2	6.3	16.5	1.0	85% - 89% Chance of Occurrence
7	0.0	0.0	2.8	15.4	2.1	
8	0.0	0.0	1.1	12.4	3.9	
9	0.0	0.0	0.4	8.8	6.1	
10	0.0	0.0	0.1	5.4	8.6	
11	0.0	0.0	0.0	3.0	10.7	
12	0.0	0.0	0.0	1.5	12.1	
13	0.0	0.0	0.0	0.7	12.3	
14	0.0	0.0	0.0	0.3	11.4	
15	0.0	0.0	0.0	0.1	9.7	
16	0.0	0.0	0.0	0.0	7.6	
17	0.0	0.0	0.0	0.0	5.5	
18	0.0	0.0	0.0	0.0	3.6	

Table 3.1.1 (b) shows the number of events having a high percent of chance of occurrence, as a function of return period, for the Sturgeon River at St. Albert flood data. This forms the basis of the first selection criterion. A certain statistical distribution conforms to the criterion when the frequency distribution curve indicates that the number of recorded events, equalling or exceeding each return period flood estimate, corresponds to the acceptable number of events listed in Table 3.1.1 (b).

TABLE 3.1.1 (b)

NUMBER OF EVENTS HAVING A HIGH CHANCE OF OCCURRENCE
STURGEON RIVER AT ST. ALBERT

Return Period (Years)	Number of Events (n)	Chance of Occurrence (%)
100	0 or 1	86.2
50	0, 1, or 2	85.9
20	1, 2, 3, 4, or 5	89.4
10	3, 4, 5, 6, 7, 8, or 9,	85.3
5	6 to 16	85.5

The flood frequency estimates are determined for the Sturgeon River at St. Albert for seven commonly used statistical distributions. These distributions are: Gumble I, log-Gumble I, normal, log-normal, 3 parameter log-normal, Pearson III, and log-Pearson III. The distribution parameters are computed using the maximum likelihood method for the majority of the statistical distributions. The exception is the Pearson III distribution, where the method of moments is used to determine the distribution parameters. The log-Pearson III distribution analysis is presented for both cases.

The flood frequency estimates for the 1:100, 1:50, 1:20, 1:10, and 1:5 year return period events are listed in Table 3.1.1 (c). The results of applying the probability theory selection criterion are listed in Table 3.1.1 (d). An example of the application of this selection technique is as follows. The three largest recorded flood events on the Sturgeon River at St. Albert were in 1974, 1948, and 1971. The flows recorded were 104, 67.5, and 45.5 cms respectively. Taking a sample distribution from Table 3.1.1 (c), such as Gumble I, the flood frequency estimate for the 1:100 year return period interval is 61.0 cms. As shown in Table 3.1.1 (d), there were two recorded flood events higher than the Gumble I estimate, therefore the Gumble I distribution was rejected.

TABLE 3.1.1 (c)

STURGEON RIVER AT ST. ALBERT
FLOOD FREQUENCY ESTIMATES (cms)

Distribution	Return Period (Years)				
	100	50	20	10	5
Gumble I	61.0	54.0	45.0	37.0	30.0
log-Gumble I	329.0	196.0	98.0	57.0	33.0
normal	59.5	55.0	48.2	42.1	34.7
log-normal	92.0	75.0	55.0	42.0	30.0
log-normal-3	92.0	75.0	55.0	42.0	30.0
Pearson III[1]	80.1	68.8	53.9	42.6	31.1
log-Pearson III	83.0	69.0	53.0	41.0	30.0
log-Pearson III[1]	86.0	71.0	53.0	41.0	30.0

1 based on method of moments

TABLE 3.1.1 (d)
STURGEON RIVER AT ST. ALBERT
PROBABILITY THEORY SELECTION CRITERION

Distribution	Return Period (Years)					Remarks
	100	50	20	10	5	
Gumble I	2	2	3	9	14	Reject
log-Gumble I	0	0	1	2	11	Reject
normal	2	2	2	6	10	Reject
log-normal	1	1	2	6	14	Accept
log-normal-3	1	1	2	6	14	Accept
Pearson III[1]	1	1	2	4	12	Accept
log-Pearson III	1	1	2	6	14	Accept
log-Pearson III[1]	1	1	2	6	14	Accept

1 based on method of moments

As shown in Table 3.1.1 (d), five of the distributions are acceptable based on the probability theory selection criterion. They are: log-normal, 3 parameter log-normal, Pearson III, log-Pearson III, and log-Pearson III based on method of moments.

3.1.2 Frequency Distribution Selection Theory

Since five of the frequency distributions may be used to assign the flood probabilities, a further selection process must be undertaken to identify which of the five distributions is the most probable to represent the data set.

The second selection criterion used was the, "Selection of Probability Distributions and Plotting Positions" theory (Lin, 1984). The selection of probability distribution and plotting position theory is based on the probabilities of getting a data sample of the observed data from the distribution population with weights on : Q_1; Q_1 and Q_2; Q_1, Q_2, and Q_3;...; and Q_1, Q_2, Q_3, ... and Q_m, respectively, with the flow data arranged in descending order.

The Equations 3.1.2 (a) through 3.1.2 (e) describe the methodology, and are provided below.

$$P_1 = n(1-P_1)^{n-1}P_1 \qquad \text{...Eq 3.1.2 (a)}$$

$$P_{21} = n(n-1)(1-P_2)^{n-2}(P_2-P_1)P_1 \qquad \text{...Eq 3.1.2 (b)}$$

$$P_{321} = n(n-1)(n-2)(1-P_3)^{n-3}(P_3-P_2)(P_2-P_1)P_1 \qquad \text{...Eq 3.1.2 (c)}$$

or in the generalization form:

$$P_m(m-1) = n(n-1)..(n-m+1)(1-P_m)^{n-m}(P_m-P_m-1)..(P_2-P_1)P_1 \qquad \text{...Eq 3.1.2 (d)}$$

$$(\text{for } m = 1, 2, ..., n-1)$$

where;

$$P_i = \frac{F(Q_i) + F(Q_i+1)}{2} \qquad \text{...Eq 3.1.2 (e)}$$

$$(\text{for } i = 1, 2, ...,m)$$

and $F(Q_i)$ = exceedance probability of Q_i

The five frequency distributions are plotted in Figure 3.1.2. The exceedance probabilities for the recorded high flows for each of the five distributions, as calculated from Figure 3.1.2, are listed in Table 3.1.2 (a).

TABLE 3.1.2 (a)

EXCEEDANCE PROBABILITIES FOR THE HIGH RECORDED FLOWS FOR THE STURGEON RIVER AT ST. ALBERT

Probability Distribution	$F(Q_1)$	$F(Q_2)$	$F(Q_3)$	$F(Q_4)$	$F(Q_5)$
log-normal	0.0065	0.0280	0.0810	0.0840	0.0960
log-normal-3	0.0065	0.0280	0.0810	0.0840	0.0960
Pearson III[1]	0.0023	0.0230	0.0820	0.0840	0.0970
log Pearson III	0.0039	0.0220	0.0790	0.0800	0.0900
log-Pearson III[1]	0.0047	0.0230	0.0790	0.0800	0.0900

[1] based on method of moments

The sample probabilities for the high recorded flows for the Sturgeon River at St. Albert are provided in Table 3.1.2 (b). Table 3.1.2 (b) was calculated using the equations presented in section 3.1.2 with the data of Table 3.1.2 (a).

TABLE 3.1.2 (b)

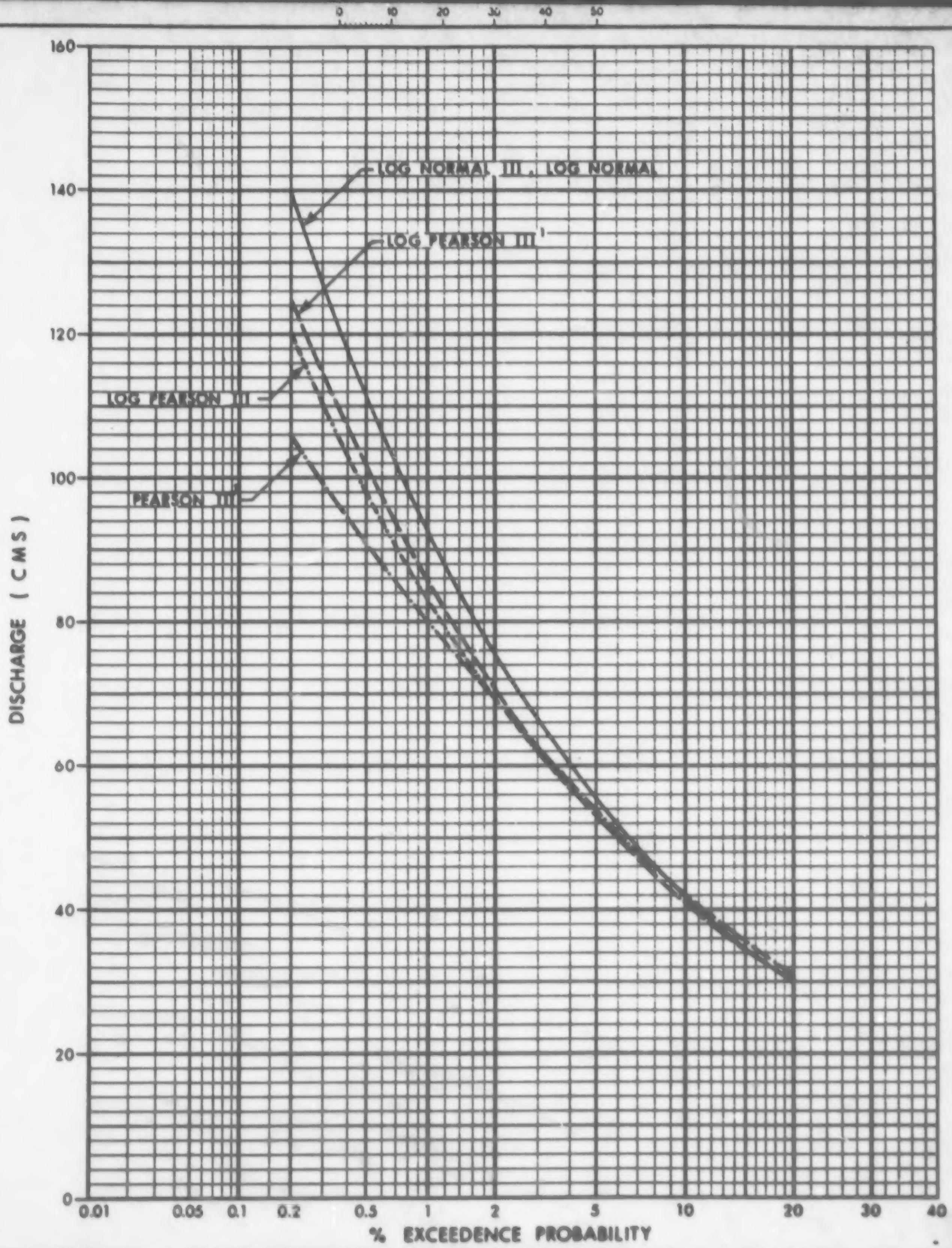
SAMPLE PROBABILITIES FOR THE ESTIMATION OF THE RECORDED HIGH FLOWS FOR THE STURGEON RIVER AT ST. ALBERT

Probability Distribution	P_1	P_{21}	P_{321}	P_{4321}
log-normal	0.36818	0.07829	0.02265	0.00696
log-normal-3	0.36818	0.07829	0.02265	0.00696
Pearson III[1]	0.36405	0.07016	0.01871	0.00575
log-Pearson III	0.36550	0.07730	0.02174	0.00559
log-Pearson III[1]	0.36873	0.07912	0.02260	0.00581

[1] based on method of moments

MICROFILM DATE

DRAWING No



Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION HYDROLOGY BRANCH	STURGEON RIVER AT ST. ALBERT FREQUENCY PLOTS OF MAXIMUM DAILY DISCHARGES
SUBMITTED A. DE BOER, P. ENG DATE NOV., 1984	DESIGNED G. W. GUENTHER CHECKED	
APPROVED M. MUSTAPHA, P. ENG. DATE NOV., 1984	DRAWN V. DA SILVA CHECKED G. W. GUENTHER	SCALE AS SHOWN DATE NOV., 1984
		FIGURE No. 3.1.2

FILE No

The distributions were then ranked from the most probable distribution to the least probable. The ranks of the sample probabilities are listed in Table 3.1.2 (c).

TABLE 3.1.2 (c)

RANKS OF SAMPLE PROBABILITIES FOR THE ESTIMATION OF THE RECORDED HIGH FLOWS FOR THE STURGEON RIVER AT ST. ALBERT

Probability Distribution	P_1	P_{21}	P_{321}	P_{4321}	Remarks
log-normal	2	2	1	1	Accept
log-normal-3	2	2	1	1	Accept
Pearson III[1]	5	5	5	4	Reject
log-Pearson III	4	4	4	5	Reject
log-Pearson III[1]	1	1	3	3	Reject

1 based on the method of moments

As shown in Table 3.1.2 (c), the two frequency distributions acceptable by this selection criterion are log-normal and 3 parameter log-normal. Since the results for both distributions are identical, the log-normal distribution was used to represent the maximum daily discharge data for the Sturgeon River at St. Albert.

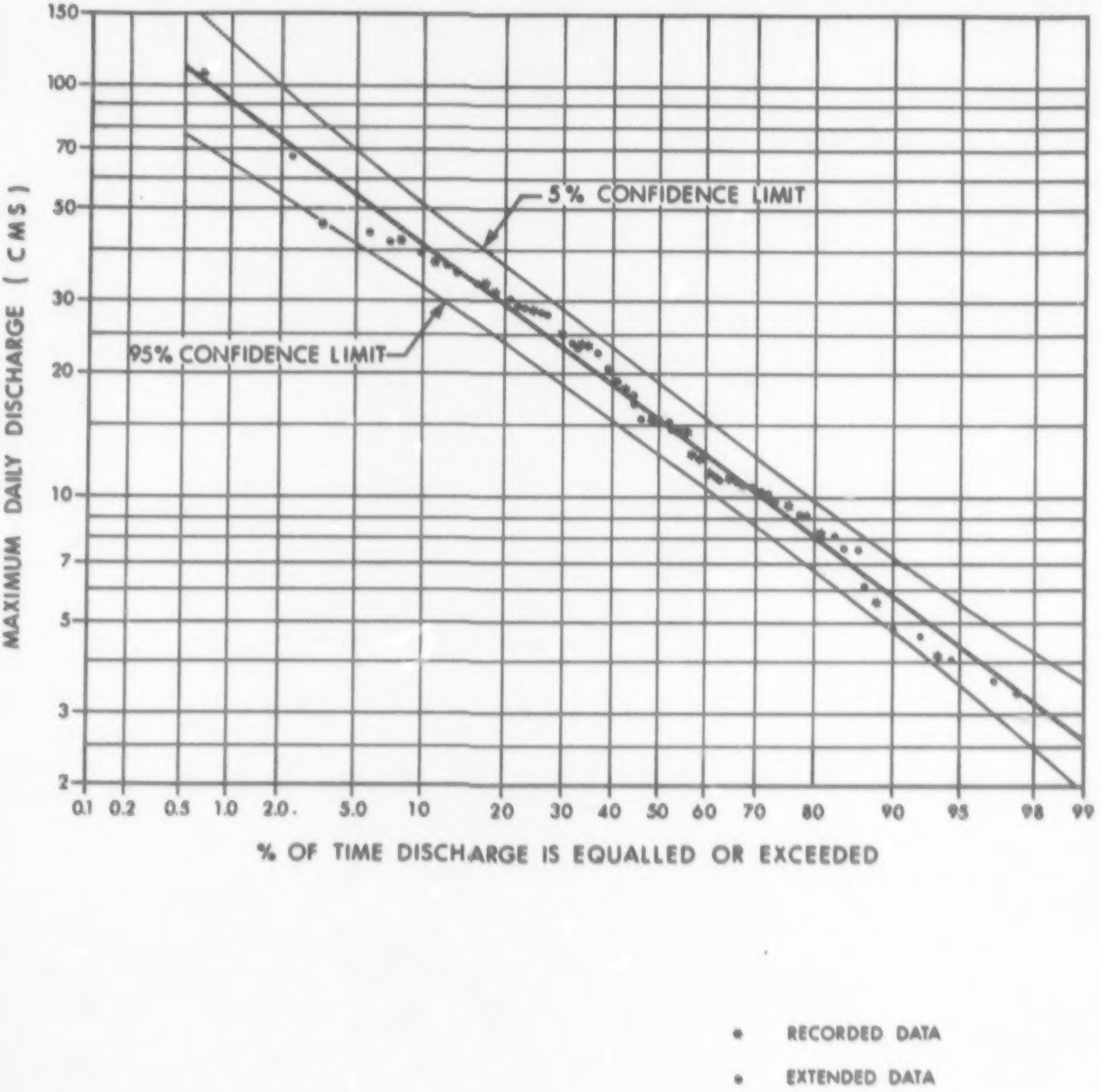
3.2 Flood Frequency Estimates

Flood frequency estimates for the St. Albert Study area, are based on the 65 years of extended records using a log-normal frequency distribution. The results of the frequency analysis are provided in Table 3.2 and plotted in Figure 3.2.

TABLE 3.2

STURGEON RIVER AT ST. ALBERT
FLOOD FREQUENCY ESTIMATES

Return Period (Years)	Maximum Daily Discharge (cms)
1:200	111
1:100	92
1:50	75
1:20	55
1:10	42
1:5	30



Alberta
ENVIRONMENT

TECHNICAL SERVICES DIVISION
HYDROLOGY BRANCH

FLOOD FREQUENCY CURVE
STURGEON RIVER AT ST. ALBERT

SUBMITTED A. DE BOER, P. ENG.
DATE NOV., 1984
APPROVED M. MUSTAPHA, P. ENG.
DATE NOV., 1984

DESIGNED G. W. GUENTHER
CHECKED
DRAWN V. DA SILVA
CHECKED G. W. GUENTHER

SCALE AS SHOWN
DATE NOV., 1984

FIGURE No. 3.2

5. SUMMARY

Current flood frequency estimates for the Sturgeon River through the City of St. Albert were required for delineating floodplain boundaries. The annual flood series at St. Albert was extended by correlation with the recorded surface water runoff data at Fort Saskatchewan. The log-normal distribution provided the best flood estimates for the recorded data. The 1:100 year return period flood peak for the Sturgeon River at St. Albert is estimated to be 92 cms. The results reflect the most current information and methodologies available and are recommended for delineating floodplain boundaries for the City of St. Albert Floodplain Study.

REFERENCES

1. ENVIRONMENT CANADA, Historical Streamflow Summary (Alberta), Inland Waters Directorate, Water Resources Branch, Water Survey of Canada, Ottawa, 1982.

2. LIN, W., Selection of Probability Distribution and Plotting Positions, Alberta Environment, Hydrology Branch, Unpublished, 1984.

3. SZABON, W., Floodplain Study- Sturgeon River through St. Albert, Alberta Environment, River Engineering Branch, Edmonton, 1975.

APPENDIX C

MODEL CALIBRATION AND SENSITIVITY ANALYSIS

This appendix contains the results of the Sturgeon River HEC-2 Model calibration and sensitivity analysis.

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C-3 Calibration Results - 1982 Event C-3

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1.0 HIGH WATER MARK DATA

High water mark data for the Sturgeon River at St. Albert is available for two flood events, namely the 1974 flood of record (Q=104 m^3/s) and the more modest 1982 event (Q=33.6 m^3/s). The former has an estimated return period of just over 100 years whereas the later had a return period of under 10 years.

The high water mark data is summarized in Table C-1.

TABLE C-1

Highwater Mark Data

Location		Year	Ref. No.	High Water Mark (m)
CNR Bridge 2	(d/s side)	1982	82.1	652.06
Perron St. Bridge		1974	----	653.22
	(u/s side)	1982	82.2	652.15
	(d/s side)	1982	82.3	652.14
Hwy 2 Bridge		1974	----	653.16
	(u/s side)	1982	82.4	652.09
	(d/s side)	1982	82.5	652.08
Boudreau Bridge	(d/s side)	1982	82.6	651.94

2.0 CALIBRATION PROCEDURE

The HEC-2 computer program described in Sections 4.1 and 4.2 (main report) was calibrated to the 1974 and 1982 high water mark data. This was accomplished by adjusting the channel roughness coefficient (Manning's 'n') in the model until computed water levels closely matched the surveyed high water marks for the two flood events. In the case of the 1974 flood an acceptable calibration was achieved using a Manning's 'n' of 0.037, whereas for the 1982 flood an 'n' value of 0.049 produced the best results. Tables C-2 and C-3 provide a comparison between the computed water levels and surveyed high water marks for these events.

3.0 MODEL SENSITIVITY

Checks were made to test the sensitivity of the HEC-2 model to variations in the water elevation determined for both the downstream starting condition and the hydraulic roughness coefficient.

3.1 Downstream Starting Condition

Based on an assessment of channel characteristics immediately downstream of the study reach it was decided that a normal depth calculation would provide the best estimate of actual flow conditions. Consequently, the model was initiated by letting the program compute normal depth at Cross-section 24, assuming an energy slope of 0.0001.

The sensitivity of the model to the chosen starting condition was tested by comparing the computed water level at several upstream cross-sections as determined by three different starting conditions, namely:

1. Normal Depth (selected method)
2. Critical Depth
3. Normal Depth +0.3 m

The results are presented in Table C-4 which shows that the profile generated with the Critical Depth starting condition converges rapidly to within 0.19 m of the selected profile (Normal Depth starting condition) at Cross-Section 22 (located at the eastern city limits) and to within 0.06 m of the selected profile at Cross-Section 16.4 (downstream side of Boudreau Bridge). Similarly, the profile generated with the Normal Depth + 0.3 m converges to within 0.22 m and 0.05 m of the selected profile at Sections 22 and 16.4, respectively. These results indicate that the model is not overly sensitive to variation in the initial starting condition.

3.2 Variation in Channel Roughness

The sensitivity of the HEC-2 model to potential changes in the hydraulic roughness coefficient (Manning's 'n') was tested by running the model at the design discharge (Q=92 cms) with the roughness parameter varied from 0.032 (selected 'n' - 0.005) to 0.042 (selected 'n' + 0.005). The results are presented in Table C-5 which shows that increasing or decreasing the selected 'n' value (0.037) by 0.005 did not change computed water levels by much more than 0.1 m. This indicates that the model is not overly sensitive to modest variations in hydraulic roughness.

TABLE C-2

Calibration Results - 1974 Event

HWM Location	X-Section No.	HWM Elevation (m)	Computed* Water Level (m)	Δh (m)
Perron St. Bridge	9.3	653.22	653.22	-----
Hwy 2 Bridge	10	653.16	653.08	-.08

---

* Using a Manning's 'n' of 0.037

TABLE C-3

Calibration Results - 1982 Event

HWM Location		X-Section No.	HWM Elevation (m)	Computed* Water Level (m)	Δh (m)
CNR Bridge	(d/s side)	6	652.06	652.19	+.13
Perron St. Bridge	(u/s side)	9.3	652.15	652.11	-.04
	(d/s side)	9.4	652.14	652.11	-.03
Hwy 2 Bridge	(u/s side)	10.3	652.09	652.04	-.05
	(d/s side)	10.4	652.08	652.03	-.05
Boudreau Bridge	(d/s side)	16.4	651.94	651.74	-.20

---

* Using a Manning's 'n' of 0.049.

TABLE C-4
Model Sensitivity to Initial Starting Condition

X-Section No.	Cumulative Distance (m)	Computed Water Level(m) for Starting Condition: Normal Depth	Critical Depth	[1]	Normal Depth +0.3 m	[2]
24	0	651.68	650.61	(-1.07)	651.98	(+.30)
22	995	651.81	651.62	(-.19)	652.03	(+.22)
19	2120	652.11	[illegible]52.02	(-.09)	652.24	(+.13)
16.4	3121	652.38	652.32	(-.06)	652.47	(+.05)

---

(1) Elevation difference between the computed water level for the Critical Depth starting condition and the Normal Depth starting condition

(2) Elevation difference between the computed water level for the Normal Depth +0.3 m starting condition and the Normal Depth starting condition

TABLE C-5
Model Sensitivity to Channel Roughness (Manning's 'n')

Location	X-Section No.	Computed Water Level (m): n=0.037	n=0.032	[1]	n=0.042	[2]
East City Limit	22	651.81	651.79	[-.03]	651.84	(+.03)
Boudreau Road (d/s)	16.4	652.38	652.28	[-.10]	652.46	(+.08)
St. Albert Trail (d/s)	10.4	652.81	652.67	[-.14]	652.92	(+.11)
Perron Street (d/s)	9.4	652.94	652.81	[-.13]	653.05	(+.11)
CNR Bridge (d/s)	6.4	653.08	652.94	[-.14]	653.19	(+.11)
Outlet of Big Lake	1	653.16	653.03	[-.13]	653.27	(+.11)

---

[1] Elevation difference between the computed water level for n=.032 and n=.037 (Average = -0.11 m)

[2] Elevation difference between the computed water level for n=.042 and n=.037 (Average = + 0.09 m)

APPENDIX D

COMPUTER INPUT/OUTPUT

This appendix contains HEC-2 computer input/output for the final 1:100 year (design flood) model runs.

Contents

1. 1:100 year - final run (existing conditions).
2. 1:100 year - final run (with floodway encroachments).

```
1***************************************************             ****************************************
 *  WATER SURFACE PROFILES                          *              *  U.S. ARMY CORPS OF ENGINEERS
 *
 *  VERSION OF NOVEMBER 1976                        *              *  THE HYDROLOGIC ENGINEERING CENTER
 *
 *  UPDATED MAY 1984                                *              *  609 SECOND STREET, SUITE D
 *
 *  IBM-PC-XT VERSION AUGUST 1985                   *              *  DAVIS, CALIFORNIA 95616
 *
 *  RUN DATE  09-13-90   TIME  11:15:04               *             *  (916) 440-2105 (FTS) 448-2105
  *
 ***************************************************             ****************************************


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                              X     X  X        X                      X
                              XXXXXXX  XXXX     X         XXXXX   XXXXX
                              X     X  X        X                X
                              X     X  X        X     X          X
                              X     X  XXXXXXX   XXXXX           XXXXXXX
I
 09-13-90     11:15:04                                                                            PAGE    1



                                                                    THIS RUN EXECUTED 09-13-90
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   HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
   ERROR CORR -  01,02,03,04,05,06
   MODIFICATION -  50,51,52,53,54,55,56
   IBM-PC-XT VERSION AUGUST 1985
 ***************************************************


 C
 T1 St. Albert FDR                                    1/100 year 92 m3/s
 T2 revised numbering - all distances planimetered **** existing conditions ****
 T3 Sturgeon River at St.Albert    B Yaremko       ***** as defined on plan ****

 J1  ICHECK     INQ       NINV      IDIR      STRT      METRIC     HVINS     Q        WSEL       FQ

        0.        0.        0.        0.   .000100      1.00        .0      92.   651.680      .000

 J2  NPROF      IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM      ITRACE

     -1.000      .000    -1.000      .000      .000      .000      .000      .000      .000      .000

 J3  VARIABLE CODES FOR SUMMARY PRINTOUT

      38.000     1.000    43.000    39.000    16.000    17.000    18.000    13.000    14.000    15.000


      62.000    10.000      .000      .000      .000      .000      .000      .000      .000      .000

 J6  IHLEQ      ICOPY

      1.000      .000      .000      .000      .000      .000      .000      .000      .000      .000


 NC       .000       .000       .000        .200       .400        .000        .000        .000        .000        .000
 NH      6.000       .100     36.040        .035    239.150        .045     577.070        .032     594.020        .070
 NH    761.420       .035   1177.540        .000       .000        .000        .000        .000        .000        .000
 X1     24.000     45.000    577.070     595.070       .000        .000        .000        .000        .000        .000
 GR    655.930       .000    655.320       1.590    654.540       2.600     653.380      15.290     652.640      36.040
 GR    651.540     82.050    651.400     132.910    651.450     194.550     651.330     239.150     650.980     275.300
 GR    650.920    335.230    650.850     389.640    650.880     439.740     651.000     496.220     651.610     537.860
 GR    651.260    550.940    650.920     556.980    650.290     562.420     650.000     568.550     650.110     573.060
 GR    650.160    577.070    649.880     578.750    649.280     580.670     649.000     583.460     649.110     585.970
 GR    649.230    589.350    649.540     591.540    649.870     594.020     649.980     595.070     649.920     610.570
 GR    650.070    622.620    651.040     628.540    650.880     662.040     650.780     682.430     651.110     695.240
 GR    651.230    722.900    651.400     761.420    651.700     794.570     651.900     838.990     652.440     890.920
 GR    653.370    942.990    654.420     985.800    655.260    1043.060     656.290    1108.810     658.320    1177.540

 NH      6.000       .100    119.310        .035    346.510        .050     593.360        .032     619.630        .150
 NH    683.070       .035    786.380        .000       .000        .000        .000        .000        .000        .000
 X1     23.000     41.000    600.390     632.140    470.000     445.000     470.000        .000        .000        .000
 GR    656.880       .000    655.650       3.870    654.950       8.340     654.270      16.210     653.310      25.760
 GR    652.590     38.180    651.600      64.770    651.550      88.620     651.250     119.310     651.310     131.170
 GR    651.130    180.370    651.140     250.460    651.480     312.850     651.410     346.510     651.610     395.040
 GR    651.240    462.440    650.620     508.630    650.740     540.300     650.840     561.270     650.330     577.520
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 GR    650.030    593.360    650.060     600.390    649.940     601.710     649.410     603.310     649.350     608.090
 GR    649.180    611.040    649.180     613.000    649.240     614.880     649.530     617.350     649.930     619.630
 GR    650.700    622.790    651.800     626.130    653.070     632.140     653.760     645.810     654.320     661.060
 GR    654.560    672.780    654.800     683.070    655.040     692.360     655.810     725.850     656.940     757.280
 GR    658.670    786.380       .000        .000       .000        .000        .000        .000        .000        .000

 NH      4.000       .035    175.320        .032    193.970        .050     267.280        .150     469.170        .000
 X1     22.000     26.000    173.130     211.080    305.000     440.000     525.000        .000        .000        .000
 GR    655.900       .000    654.070      14.190    652.630      36.750     651.860      69.090     651.550     110.370
 GR    651.620    144.560    651.670     173.130    651.550     174.270     650.630     175.320     649.950     176.090
 GR    649.460    176.850    648.870     180.080    649.060     183.930     649.430     186.680     649.860     189.160
 GR    649.940    193.970    650.220     211.080    650.360     214.230     650.500     216.350     650.700     242.910
 GR    650.640    267.280    651.220     283.340    651.060     330.570     651.390     384.140     652.360     425.610
 GR    653.160    469.170       .000        .000       .000        .000        .000        .000        .000        .000

 NH      4.000       .035    337.650        .032    360.450        .120     498.950        .035     588.250        .000
 X1     21.000     52.000    334.950     382.750    430.000     315.000     410.000        .000        .000        .000
 GR    656.020       .000    654.980     30.380    653.890     68.500    653.490     93.190    653.540    101.270
 GR    652.900    132.100    652.590    156.780    652.270    185.710    652.310    225.260    651.610    265.850
 GR    651.490    286.180    651.310    294.150    650.620    305.350    650.430    318.150    650.470    324.150
 GR    650.520    334.950    650.260    337.650    650.010    339.350    649.870    340.550    649.590    341.050
 GR    649.480    345.350    649.280    349.850    649.100    354.950    649.160    357.050    649.340    358.150
 GR    649.860    359.250    649.970    360.450    650.050    361.350    650.110    371.950    650.270    377.250
 GR    650.910    380.150    651.010    381.850    651.090    382.780    650.930    397.850    650.880    411.650
 GR    650.740    423.650    650.760    439.550    650.960    442.750    651.160    456.450    651.520    462.450
 GR    652.250    469.650    652.500    472.750    652.010    485.850    653.100    498.950    653.170    516.350
 GR    653.390    530.150    653.910    544.050    654.450    556.150    654.840    562.750    655.130    570.350
 GR    655.280    580.950    655.480    588.250       .000       .000       .000       .000       .000       .000

 NH      6.000       .035    350.940       .120    423.210       .050    448.260       .032    477.080       .150
 NH    538.900       .035    635.130       .000       .000       .000       .000       .000       .000       .000
 X1     20.000     52.000    448.260    486.270    285.000    315.000    325.000       .000       .000       .000
 GR    659.010       .000    657.220     23.570    655.550     47.610    654.780     70.060    653.310     97.880
 GR    652.740    127.620    652.560    142.690    652.560    160.680    652.720    162.790    652.500    194.570
 GR    652.210    234.830    652.300    274.870    652.480    300.520    652.910    323.700    653.200    332.200
 GR    653.050    350.940    652.290    355.440    651.800    357.270    650.970    381.230    650.960    401.940
 GR    650.940    423.210    650.720    432.490    650.580    439.310    650.390    448.260    650.330    449.650
 GR    650.210    451.850    650.070    453.530    649.890    456.430    649.500    459.130    649.380    462.110
 GR    649.070    466.540    648.920    470.440    649.260    473.860    649.870    475.330    649.960    475.760
 GR    650.360    477.080    651.060    481.140    651.700    486.270    651.770    492.750    651.880    513.650
 GR    652.480    526.560    653.150    529.120    654.000    534.640    654.450    537.260    654.950    538.900
 GR    655.790    545.200    656.060    548.020    656.690    566.020    657.190    595.600    657.320    614.240
 GR    657.600    629.620    657.810    635.130       .000       .000       .000       .000       .000       .000

 NH      6.000       .035    253.140       .080    373.330       .032    394.330       .050    423.330       .100
 NH    431.930       .035    488.450       .000       .000       .000       .000       .000       .000       .000
 X1     19.000     43.000    355.330    408.230    290.000    425.000    390.000       .000       .000       .000
 GR    672.590       .000    671.400     32.540    669.540     55.320    667.440     76.410    665.080     97.360
 GR    662.750    116.930    660.640    133.630    658.300    155.200    656.370    186.170    653.900    228.140
 GR    653.320    253.140    652.110    272.430    652.390    287.810    651.950    316.380    651.970    328.860
 GR    651.240    339.850    650.950    345.330    650.640    355.330    650.170    365.330    649.920    370.330
 GR    650.010    373.330    649.860    373.730    649.410    379.630    649.210    382.030    649.030    385.930
 GR    649.160    387.930    649.410    391.330    649.860    394.330    650.020    398.830    650.270    404.330
 GR    650.860    408.230    651.360    414.330    651.640    421.030    652.210    423.330    653.400    428.630
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 GR    654.610    431.930    655.070    436.330    655.170    437.570    660.750    458.390    660.720    477.720
 GR    660.860    486.620    660.900    488.110    660.730    488.450       .000       .000       .000       .000

 NH      6.000       .035     36.150       .100     69.910       .050     84.200       .032    108.900       .070
 NH    165.100       .030    315.770       .000       .000       .000       .000       .000       .000       .000
 X1     18.000     48.000     78.700    133.700    250.000    270.000    265.000       .000       .000       .000
 GR    666.980       .000    665.800     15.780    664.460     36.150    663.490     53.110    662.060     58.550
 GR    660.460     62.270    658.690     65.540    656.320     69.910    653.800     73.090    651.660     77.060
 GR    651.050     78.700    650.490     82.700    650.080     84.200    649.910     85.500    649.470     88.900
 GR    649.270     90.600    649.180     92.900    649.270     98.200    649.390    101.200    649.540    103.400
 GR    649.620    105.700    649.910    108.900    650.140    113.600    650.400    118.200    650.860    125.800
 GR    651.060    129.320    651.040    133.700    651.090    146.690    651.020    151.400    651.100    165.100
 GR    651.580    173.100    651.840    173.880    652.760    175.170    653.050    175.900    653.200    176.570
 GR    653.220    178.230    653.890    188.690    654.200    214.080    654.490    237.700    654.670    257.380
 GR    654.630    270.890    654.890    289.050    655.080    305.610    655.120    307.050    654.980    307.430
 GR    654.920    311.230    654.910    315.480    655.000    315.770       .000       .000       .000       .000

 NH      5.000       .100     15.210       .060     44.500       .032     68.300       .090    129.250       .030
 NH    356.090       .000       .000       .000       .000       .000       .000       .000       .000       .000
 X1     17.000     43.000     29.960     91.500    345.000    290.000    335.000       .000       .000       .000
 GR    663.260       .000    661.980      2.150    658.400      6.640    655.960      9.890    653.580     13.040
 GR    652.080     15.210    651.320     20.040    651.060     29.960    650.430     35.500    650.170     40.500
 GR    650.120     44.500    649.950     45.500    649.750     46.800    649.450     49.900    649.200     53.500
 GR    649.180     58.100    649.400     63.200    649.570     66.000    649.950     68.300    650.190     69.800
 GR    650.370     74.500    650.700     83.400    650.960     91.500    651.250    100.700    651.670    109.500
 GR    651.860    117.200    652.310    119.100    653.330    125.700    654.130    129.250    654.460    132.060
 GR    654.310    147.300    653.750    184.720    653.900    220.640    654.370    263.520    654.580    287.060
 GR    655.390    306.240    655.640    330.080    655.690    346.350    655.800    348.250    655.610    348.700
 GR    655.580    351.660    655.580    355.140    655.700    356.090       .000       .000       .000       .000

 NC       .000       .000       .000       .300       .500       .000       .000       .000       .000       .000
 NH      3.000       .080    143.220       .032    166.620       .070    352.440       .000       .000       .000
 X1     16.500     30.000    123.650    187.750    400.000    395.000    400.000       .000       .000       .000
 GR    656.380       .000    656.180       .010    656.300     35.500    656.170     74.230    655.890    114.310
 GR    655.640    123.650    655.280    124.620    653.700    128.720    652.490    133.420    651.460    138.420
 GR    650.430    143.220    649.960    143.820    649.760    144.820    649.480    149.420    649.510    154.320
 GR    649.360    157.020    649.330    160.120    649.330    161.820    649.960    166.620    650.310    168.320
 GR    651.140    171.420    652.820    178.120    653.880    182.620    655.100    186.420    655.400    187.750
 GR    655.530    218.580    655.550    253.500    655.810    286.360    656.240    317.090    656.840    352.440

 NH      3.000       .025    138.420       .032    171.420       .025    230.000       .000       .000       .000
               BOUDREAU ROAD BRIDGE
 X1     16.400     29.000    128.720    182.622      1.000      1.000      1.000       .000       .000       .000
 X2       .000       .000       .000    654.120    655.400       .000       .000       .000       .000       .000
 X3     10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000
 GR    655.890    114.310    655.710    128.720    654.420    128.721    653.700    128.722    652.490    133.420
 GR    651.460    138.420    650.430    142.720    654.310    142.721    654.310    143.720    650.430    143.721
 GR    649.960    143.820    649.760    144.820    649.480    149.420    649.510    154.320    649.360    157.020
 GR    649.330    160.120    649.330    161.820    649.960    166.620    650.310    167.820    654.210    167.821
 GR    654.210    168.820    650.310    168.821    651.140    171.420    652.820    178.120    653.880    182.620
 GR    654.120    182.621    655.410    182.622    655.390    200.000    655.320    230.000       .000       .000
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 X1     16.300       .000       .000       .000     24.000     24.000     24.000       .000       .000       .000
 X2       .000       .000       .000    654.120    655.400       .000       .000       .000       .000       .000

 NH      3.000       .040    143.220       .032    166.620       .070    352.440       .000       .000       .000
 X1     16.200     30.000    123.650    187.750      1.000      1.000      1.000       .000       .000       .000
 GR    656.380       .000    656.180       .010    656.300     35.500    656.170     74.230    655.890    114.310
 GR    655.640    123.650    655.280    124.620    653.700    128.720    652.490    133.420    651.460    138.420
 GR    650.430    143.220    649.960    143.820    649.760    144.820    649.480    149.420    649.510    154.320
 GR    649.360    157.020    649.330    160.120    649.330    161.820    649.960    166.620    650.310    168.320
 GR    651.140    171.420    652.820    178.120    653.880    182.620    655.100    186.420    655.400    187.750
 GR    655.530    218.580    655.550    253.500    655.810    286.360    656.240    317.090    656.840    352.440
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NC        .000       .000       .000       .200       .400       .000       .000       .000       .000       .000
NH       3.000       .050    159.740       .032    182.040       .080    323.680       .000       .000       .000
X1      15.000     55.000    151.230    203.740    170.000    175.000    170.000       .000       .000       .000
GR     662.520       .000    662.050      3.810    661.160      7.510    660.700     10.510    660.060     13.170
GR     659.280     15.750    658.790     19.570    658.050     25.300    657.110     36.420    656.670     43.020
GR     656.580     47.830    656.800     51.240    656.770     61.900    656.770     69.070    657.290     71.600
GR     656.710     78.120    656.000     84.050    655.100     93.630    654.360    103.540    653.740    113.640
GR     652.940    137.400    652.030    150.400    652.410    151.230    652.330    151.740    651.280    155.740
GR     650.780    158.740    650.260    159.740    649.960    160.740    649.660    162.940    649.360    164.940
GR     648.910    169.340    649.210    172.140    649.480    174.740    649.590    177.340    649.610    179.240
GR     649.960    182.040    650.250    183.740    650.330    188.440    650.480    195.740    650.890    203.740
GR     650.860    210.740    650.840    221.740    650.780    234.140    651.120    237.580    651.260    240.740
GR     651.690    266.870    652.210    290.560    653.190    300.410    654.170    306.110    654.570    307.240
GR     655.000    308.700    655.450    311.320    655.680    315.740    655.800    319.340    655.640    323.680

NH       3.000       .030     74.800       .032    100.900       .150    356.340       .000       .000       .000
X1      14.000     46.000     45.500    106.400    325.000    315.000    300.000       .000       .000       .000
GR     656.360       .000    655.790      3.500    655.060      7.300    654.460     10.300    654.010     13.200
GR     653.830     20.800    653.680     29.200    653.560     37.400    653.420     45.500    653.000     50.700
GR     652.510     55.000    652.100     58.800    651.580     62.300    650.850     67.300    650.390     69.800
GR     650.120     74.800    649.980     80.300    649.680     82.700    649.430     87.400    649.180     91.500
GR     649.180     95.400    649.580     99.500    649.980    100.900    650.060    101.000    650.510    101.500
GR     650.840    104.600    651.200    105.100    651.650    106.400    651.590    108.900    652.080    118.250
GR     652.200    125.930    652.400    139.890    652.660    157.420    652.640    176.000    653.900    192.460
GR     653.230    205.550    653.740    213.650    655.060    220.350    654.630    224.760    654.430    227.500
GR     654.560    233.960    654.430    245.920    654.590    269.620    654.700    290.210    655.020    320.800
GR     655.420    356.340       .000       .000       .000       .000       .000       .000       .000       .000

NH       4.000       .030    312.710       .032    340.910       .030    363.210       .070    487.560       .000
X1      13.000     44.000    307.710    351.010    185.000    210.000    210.000       .000       .000       .000
GR     658.720       .000    658.740      1.510    657.500      6.520    657.020      9.320    655.790     37.220
GR     654.940     73.010    654.460    124.310    654.840    162.190    654.780    204.930    654.080    251.790
GR     653.030    283.200    652.490    294.330    652.320    297.710    651.970    302.710    651.340    307.710
GR     650.070    312.710    650.000    313.910    649.550    316.810    649.350    318.510    649.280    324.410
GR     649.500    329.010    649.800    335.510    650.000    340.910    650.060    343.810    650.400    345.010
GR     650.780    347.510    651.050    351.010    651.210    363.210    651.340    375.810    651.950    378.810
GR     653.000    382.610    653.770    385.110    654.590    389.710    655.150    391.940    655.200    409.830
GR     655.040    425.000    655.140    430.000    655.080    434.570    655.290    445.070    655.420    451.840
GR     655.420    465.290    655.690    474.050    655.870    481.400    656.030    487.560       .000       .000
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NH       3.000       .030     75.830       .032     98.630       .030    148.970       .000       .000       .000
X1      12.400     25.000     54.830    123.830    190.000    200.000    195.000       .000       .000       .000
X3      10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000
GR     654.310       .000    654.200      4.120    654.310     21.750    654.510     21.750    654.600     41.330
GR     654.330     52.100    654.250     54.830    652.200     64.830    652.200     64.840    651.740     68.830
GR     650.930     73.830    650.140     75.830    649.370     81.430    649.370     84.430    649.490     92.930
GR     649.940     95.830    650.020     98.630    650.670    103.030    651.380    108.030    651.910    114.230
GR     652.400    114.240    654.230    123.830    654.130    132.120    653.980    138.460    653.680    148.970

                REDWILLOW PARK FOOTBRIDGE
X1      12.300       .000       .000       .000      1.000      1.000      1.000       .000       .000       .000
BT     -16.000     54.830    654.250    654.250     64.830    654.640    652.200     64.840    654.640    652.390
BT        .000     68.830    654.800    653.200     73.830    654.930    653.750     75.830    655.000    653.900
BT        .000     81.430    655.060    654.140     84.430    655.080    654.220     92.930    655.080    654.260
BT        .000     95.830    655.070    654.240     98.630    655.050    654.150    103.030    655.000    653.930
BT        .000    108.030    654.870    653.440    114.230    654.670    652.400    114.240    654.670    652.400
BT        .000    123.830    654.230    654.230       .000       .000       .000       .000       .000       .000

X1      12.200       .000       .000       .000      3.000      3.000      3.000       .000       .000       .000
X2        .000       .000       .000       .000       .000       .000      1.000       .000       .000       .000

X1      12.100       .000       .000       .000      1.000      1.000      1.000       .000       .000       .000

NH       3.000       .030     64.650       .032     87.450       .060    119.650       .000       .000       .000
X1      11.000     28.000     54.650     95.650    275.000    260.000    270.000       .000       .000       .000
GR     654.460       .000    653.900      5.150    653.140     15.470    652.650     29.480    652.510     44.390
GR     652.380     44.650    652.140     54.650    651.690     59.650    651.250     61.650    650.190     64.650
GR     650.070     65.450    649.720     67.350    649.570     70.550    649.120     75.550    649.320     78.950
GR     649.420     83.550    650.070     87.450    650.660     88.650    651.280     90.650    651.930     92.850
GR     652.770     95.650    653.210     97.650    653.550    101.520    653.990    105.840    654.670    110.170
GR     655.650    115.320    656.270    118.060    656.760    119.650       .000       .000       .000       .000

NH       3.000       .030    245.980       .032    259.880       .030    480.520       .000       .000       .000
X1      10.600     59.000    229.190    275.980    266.000    331.000    306.000       .000       .000       .000
GR     656.050       .000    655.820       .010    656.050     16.950    655.770     31.190    655.910     31.191
GR     655.910     59.570    655.820     82.710    655.700     93.890    655.500     96.120    655.400    104.780
GR     655.300    104.781    655.590    136.840    655.170    160.050    655.070    160.051    655.200    175.160
GR     654.860    188.590    655.070    188.591    655.160    193.090    655.050    213.310    655.080    223.460
GR     654.830    229.190    654.550    229.970    652.780    233.980    651.690    237.180    651.220    240.480
GR     651.020    240.580    650.350    242.580    650.230    243.980    650.080    245.980    650.060    246.180
GR     650.010    246.380    649.760    247.980    649.440    250.380    649.610    251.980    649.510    256.880
GR     649.830    258.680    650.060    259.880    650.890    262.680    651.220    263.780    651.290    267.680
GR     652.160    267.780    652.910    271.280    653.760    273.880    654.420    275.980    654.510    282.000
GR     654.500    293.950    654.150    316.370    653.710    344.590    653.480    357.570    653.350    357.571
GR     653.330    375.130    653.680    385.050    653.700    395.410    653.550    406.250    653.680    406.251
GR     654.090    423.310    654.890    442.730    655.620    460.150    656.480    480.520       .000       .000

NC        .000       .000       .000       .300       .500       .000       .000       .000       .000       .000
NH       3.000       .030    245.980       .032    259.880       .030    480.520       .000       .000       .000
1
 09-13-90     11:15:04                                                                                PAGE    6

X1      10.500       .000       .000       .000     80.000     80.000     80.000       .000       .000       .000

NH       3.000       .020    245.930       .032    259.880       .020    271.281       .000       .000       .000
                HWY. 2 BRIDGE
X1      10.400     26.000    233.980    271.281      1.000      1.000      1.000       .000       .000       .000
X2        .000       .000       .000    653.560    654.900       .000       .000       .000       .000       .000
X3      10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000
GR     655.200    233.980    652.780    233.981    651.690    237.180    651.220    240.480    651.020    240.580
GR     650.350    242.980    650.230    243.980    650.080    245.930    653.560    245.931    653.560    246.830
GR     650.010    246.831    649.760    247.980    649.440    250.380    649.610    251.980    649.510    256.880
GR     649.780    258.230    653.560    258.231    653.560    259.130    649.920    259.131    650.060    259.880
GR     650.890    262.680    651.220    263.780    651.290    267.680    652.160    267.780    652.910    271.280
GR     654.900    271.281       .000       .000       .000       .000       .000       .000       .000       .000

X1      10.300       .000       .000       .000     37.900     37.900     37.900       .000       .000       .000
X2        .000       .000       .000    653.560    654.900       .000       .000       .000       .000       .000
X3      10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000

NH       3.000       .030    245.980       .032    259.880       .030    480.520       .000       .000       .000
X1      10.200     59.000    229.190    275.980      1.000      1.000      1.000       .000       .000       .000
GR     656.050       .000    655.820       .010    656.050     16.950    655.770     31.190    655.910     31.191
GR     655.910     59.570    655.820     82.710    655.700     93.890    655.500     96.120    655.400    104.780
GR     655.300    104.781    655.590    136.840    655.170    160.050    655.070    160.051    655.200    175.160
GR     654.860    188.590    655.070    188.591    655.160    193.090    655.050    213.310    655.080    223.460
GR     654.830    229.190    654.550    229.970    652.780    233.980    651.690    237.180    651.220    240.480
GR     651.020    240.580    650.350    242.580    650.230    243.980    650.080    245.980    650.060    246.180
GR     650.010    246.380    649.760    247.980    649.440    250.380    649.610    251.980    649.510    256.880
GR     649.830    258.680    650.060    259.880    650.890    262.680    651.220    263.780    651.290    267.680
GR     652.160    267.780    652.910    271.280    653.760    273.880    654.420    275.980    654.510    282.000
GR     654.500    293.950    654.150    316.370    653.710    344.590    653.480    357.570    653.350    357.571
GR     653.330    375.130    653.680    385.050    653.700    395.410    653.550    406.250    653.680    406.251
GR     654.090    423.310    654.890    442.730    655.620    460.150    656.480    480.520       .000       .000

NC        .000       .000       .000       .200       .400       .000       .000       .000       .000       .000
NH       3.000       .030    245.980       .032    259.880       .030    480.520       .000       .000       .000
X1      10.100       .000       .000       .000     38.000     38.000     38.000       .000       .000       .000
X3      10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000

NH       3.000       .030    183.900       .032    210.250       .030    549.330       .000       .000       .000
X1       9.600     60.000    176.970    220.810    185.000    170.000    175.000       .000       .000       .000
GR     657.320       .000    656.470     10.980    655.920     27.470    655.760     61.550    655.600     83.110
GR     655.400    100.530    655.320    104.710    655.070    106.790    655.110    107.830    654.850    109.950
GR     654.410    131.340    654.700    132.550    654.710    138.950    654.680    158.080    654.520    170.330
GR     654.400    172.610    654.370    174.750    654.350    175.720    654.040    176.970    652.310    179.490
GR     651.620    181.030    650.980    182.480    650.960    183.900    650.220    186.250    650.120    186.780
GR     649.950    188.990    649.820    191.210    649.490    194.690    649.550    197.960    649.580    200.220
GR     649.550    204.430    649.620    207.030    650.010    208.990    650.220    210.250    650.920    210.910
GR     650.500    212.180    651.060    214.700    651.660    216.240    653.280    219.410    654.040    220.810
GR     654.130    221.740    654.270    228.470    654.180    244.850    654.060    248.870    654.040    267.520
GR     654.050    287.910    654.100    306.520    654.260    306.521    654.350    332.070    654.190    372.450
GR     653.960    410.190    653.860    410.191    653.800    428.390    653.960    428.391    654.290    455.240
GR     654.520    478.540    654.430    490.570    655.630    527.310    656.640    543.400    656.850    549.330
1
  09-13-90     11:15:04                                                                                   PAGE    7


NC        .000       .000       .000       .300       .500       .000       .000       .000       .000       .000
NH       3.000       .030    183.900       .032    210.250       .030    549.330       .000       .000       .000
X1       9.500       .000       .000       .000     20.000     20.000     20.000       .000       .000       .000
X3      10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000

NH       3.000       .030    183.900       .032    210.250       .030    267.520       .000       .000       .000
               PERRON STREET BRIDGE
X1       9.400     34.000    179.490    216.241      1.000      1.000      1.000       .000       .000       .000
X2        .000       .000       .000    653.400    654.600       .000       .000       .000       .000       .000
X3      10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000
GR     654.560    174.000    654.620    178.000    654.620    179.490    652.310    179.491    651.620    181.030
GR     650.980    181.031    650.960    183.900    650.220    186.250    650.120    186.780    649.950    188.990
GR     649.820    190.760    653.400    190.761    653.400    191.660    649.820    191.661    649.490    194.690
GR     649.550    197.960    649.580    200.220    649.550    203.980    653.400    203.981    653.400    204.880
GR     649.550    204.881    649.620    207.030    650.010    208.990    650.220    210.250    650.920    210.910
GR     650.980    212.180    651.060    214.700    651.660    216.240    654.300    216.241    654.230    220.700
GR     654.270    228.470    654.180    244.850    654.060    248.870    654.040    267.520       .000       .000

X1       9.300       .000       .000       .000     19.600     19.600     19.600       .000       .000       .000
X2        .000       .000       .000    653.400    654.600       .000       .000       .000       .000       .000
X3      10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000

NH       3.000       .030    183.900       .032    210.250       .030    549.330       .000       .000       .000
X1       9.200     60.000    176.970    220.810      5.000      5.000      5.000       .000       .000       .000
GR     657.320       .000    656.470     10.980    655.920     27.470    655.760     61.550    655.600     83.110
GR     655.400    100.530    655.320    104.710    655.070    106.790    655.110    107.830    654.850    109.950
GR     654.410    131.340    654.700    132.550    654.710    138.950    654.680    158.080    654.520    170.330
GR     654.400    172.610    654.370    174.750    654.350    175.720    654.040    176.970    652.310    179.490
GR     651.620    181.030    650.980    182.480    650.960    183.900    650.220    186.250    650.120    186.780
GR     649.950    188.990    649.820    191.210    649.490    194.690    649.550    197.960    649.580    200.220
GR     649.550    204.430    649.620    207.030    650.010    208.990    650.220    210.250    650.920    210.910
GR     650.500    212.180    651.060    214.700    651.660    216.240    653.280    219.410    654.040    220.810
GR     654.130    221.740    654.270    228.470    654.180    244.850    654.060    248.870    654.040    267.520
GR     654.050    287.910    654.100    306.520    654.260    306.521    654.350    332.070    654.190    372.450
GR     653.960    410.190    653.860    410.191    653.800    428.390    653.960    428.391    654.290    455.240
GR     654.520    478.540    654.430    490.570    655.630    527.310    656.640    543.400    656.850    549.330

X1       9.100       .000       .000       .000     38.000     38.000     38.000       .000       .000       .000

NH       4.000       .040     49.400       .030    106.270       .032    136.470       .030    486.210       .000
X1       8.000     57.000     99.270    157.270    255.000    260.000    260.000       .000       .000       .000
X3      10.000       .000       .000       .000       .000    157.270    654.710       .000       .000       .000
GR     660.430       .000    659.550      4.190    658.710      9.450    657.920     14.120    657.070     19.480
GR     656.100     24.980    655.300     29.880    654.790     39.710    654.610     41.960    653.990     45.320
GR     652.980     49.400    652.250     56.060    651.910     71.730    651.740     83.510    651.510     94.400
GR     651.310     99.270    650.810    104.270    650.200    106.270    650.080    107.270    649.760    108.070
GR     649.630    111.070    649.530    116.570    649.530    121.870    649.530    128.970    649.730    131.570
GR     650.080    136.470    650.270    138.070    651.110    139.570    651.660    141.870    652.380    145.170
GR     653.550    149.270    654.410    152.570    654.710    157.270    654.680    158.470    654.680    167.140
GR     654.490    178.830    654.020    188.520    652.740    194.230    652.120    199.250    652.090    209.310
GR     652.260    223.090    652.640    234.750    652.700    255.300    653.030    278.150    653.350    288.160
GR     654.320    299.460    655.200    308.270    656.390    317.070    656.500    321.940    656.570    326.250
GR     656.490    326.300    656.700    345.720    658.370    399.460    659.120    430.970    659.980    464.750
1
  09-13-90     11:15:04                                                                                   PAGE    8


GR     660.140    464.970    661.400    486.210       .000       .000       .000       .000       .000       .000

NH       3.000       .030     98.160       .032    118.660       .030    475.420       .000       .000       .000
               REDWILLOW PARK FOOTBRIDGE
X1       7.000     65.000     84.400    142.870    180.000    185.000    175.000       .000       .000       .000
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X3    10.000      .000      .000      .000      .000   142.870   654.560      .000      .000      .000
GR   661.930    10.530   660.260    13.060   659.190    15.010   657.890    17.740   656.430    22.070
GR   655.870    30.690   655.240    36.060   654.630    51.470   654.280    63.230   653.970    76.260
GR   653.940    84.400   653.200    87.360   652.420    90.160   651.450    93.160   650.770    96.160
GR   650.300    98.160   650.070    98.960   649.810   101.060   649.450   103.060   649.390   105.760
GR   649.590   110.260   649.940   115.560   650.070   118.660   650.300   120.460   651.020   122.050
GR   651.300   126.760   651.510   129.360   652.280   133.160   653.070   135.840   653.700   138.140
GR   654.050   139.370   654.560   142.870   654.220   158.940   653.500   171.290   652.850   186.540
GR   652.880   204.740   653.010   221.230   653.090   237.270   653.340   256.890   653.740   274.040
GR   654.180   288.050   654.190   290.900   654.070   298.050   654.210   304.280   654.300   304.510
GR   654.530   323.190   653.790   344.470   655.110   364.830   655.590   385.830   655.850   407.050
GR   655.690   407.270   656.140   422.900   656.330   431.600   656.570   433.380   656.730   436.020
GR   656.750   436.680   656.910   436.720   657.560   448.930   657.850   459.970   658.220   469.750
GR   658.380   473.360   658.510   473.460   658.550   474.610   658.730   474.630   659.040   475.420

NH     3.000      .040    38.300      .032    64.200      .040   109.320      .000      .000      .000
X1     6.500    29.000     3.100   109.320   172.000   167.000   172.000      .000      .000      .000
GR   660.460     3.100   659.340     3.400   655.750    12.400   651.570    21.100   651.610    21.160
GR   651.380    22.300   651.180    23.300   650.870    24.800   650.650    30.800   650.320    32.300
GR   650.250    38.300   650.090    39.800   649.840    40.500   649.790    42.900   649.290    47.330
GR   649.140    51.200   649.290    55.100   649.560    60.500   650.090    64.200   650.200    65.000
GR   650.650    70.100   650.830    71.200   651.210    74.100   651.490    75.330   656.420    83.200
GR   658.250    88.900   658.440    91.400   659.290    97.820   660.960   109.320      .000      .000

NH     3.000      .040    36.740      .032    64.200      .040   109.320      .000      .000      .000
              C.N.R. BRIDGE
X1     6.400    43.000     3.100   109.320     1.000     1.000     1.000      .000      .000      .000
X2      .000      .000      .000   658.600   660.270      .000      .000      .000      .000      .000
GR   660.460     3.100   659.340     3.400   656.020    11.680   658.600    11.681   658.600    15.260
GR   654.400    15.261   652.600    18.840   658.600    18.841   658.600    22.420   651.350    22.421
GR   650.820    26.000   658.600    26.010   658.600    29.580   650.700    29.581   650.320    33.160
GR   658.600    33.161   658.600    36.740   650.270    36.741   649.950    40.320   658.600    40.321
GR   658.600    47.330   649.290    47.331   649.140    51.200   649.290    55.100   649.560    60.500
GR   650.090    64.200   650.200    65.000   650.400    67.420   658.600    67.421   658.600    70.370
GR   650.700    70.371   651.150    73.950   658.600    73.951   658.600    77.530   652.900    77.531
GR   655.200    81.110   658.600    81.111   658.600    84.690   656.900    84.691   658.250    88.900
GR   658.440    91.400   659.290    97.820   660.960   109.320      .000      .000      .000      .000

NH     3.000      .040    36.740      .032    64.200      .040   109.320      .000      .000      .000
X1     6.300      .000      .000      .000     6.700     6.700     6.700      .000      .000      .000
X2      .000      .000      .000   658.600   660.270      .000      .000      .000      .000      .000

NH     3.000      .040    38.300      .032    64.200      .040   109.320      .000      .000      .000
X1     6.200    29.000     3.100   109.320     1.000     1.000     1.000      .000      .000      .000
GR   660.460     3.100   659.340     3.400   655.750    12.400   651.570    21.100   651.610    21.160
GR   651.380    22.300   651.180    23.300   650.870    24.800   650.650    30.800   650.320    32.300
GR   650.250    38.300   650.090    39.800   649.840    40.500   649.790    42.900   649.290    47.330
GR   649.140    51.200   649.290    55.100   649.560    60.500   650.090    64.200   650.200    65.000
GR   650.650    70.100   650.830    71.200   651.210    74.100   651.490    75.330   656.420    83.200
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GR   658.250    88.900   658.440    91.400   659.290    97.820   660.960   109.320      .000      .000

NH     6.000      .035   120.470      .060   246.430      .050   293.660      .032   346.420      .050
NH   398.800      .035   612.630      .000      .000      .000      .000      .000      .000      .000
X1     5.000    58.000   293.660   363.050   370.000   390.000   380.000      .000      .000      .000
GR   658.480      .000   657.330    39.150   656.280    67.860   655.700    76.990   655.310    85.520
GR   655.030    88.670   654.680    92.550   654.200   100.090   653.640   107.070   653.070   114.590
GR   652.840   120.470   652.270   158.700   652.080   185.120   651.970   204.500   651.850   229.750
GR   651.630   246.430   651.360   260.880   650.580   293.660   650.280   300.570   650.110   303.960
GR   649.710   307.780   649.500   309.760   649.440   312.100   649.670   316.650   649.850   322.410
GR   650.030   330.000   649.980   338.170   650.050   342.280   650.260   346.420   650.750   359.580
GR   651.680   361.180   651.970   363.050   652.300   378.030   652.520   389.320   652.110   390.350
GR   651.670   391.400   652.070   394.750   652.580   398.800   653.050   404.830   653.080   406.780
GR   653.090   408.500   653.300   410.360   653.500   436.870   653.750   460.720   653.830   479.900
GR   653.910   487.790   654.000   490.680   654.320   500.060   654.390   503.260   654.910   518.650
GR   655.080   530.890   655.710   556.730   656.170   575.520   656.360   590.860   656.110   596.950
GR   656.000   600.490   656.090   605.960   657.060   612.630      .000      .000      .000      .000

NH     4.000      .035   188.260      .050   398.230      .032   487.060      .150   655.900      .000
X1     4.000    42.000   386.930   497.830   600.000   605.000   600.000      .000      .000      .000
GR   659.190      .000   658.140    23.160   657.100    55.220   655.590    89.750   654.270   126.140
GR   653.370   164.260   652.460   188.260   651.770   213.460   651.580   248.390   651.270   285.010
GR   650.990   319.890   651.030   354.050   650.950   375.360   650.830   386.930   650.490   398.230
GR   650.440   406.600   649.970   409.570   649.820   413.370   649.740   422.220   649.650   433.990
GR   649.680   445.660   649.800   456.700   649.890   462.770   649.950   464.950   650.300   470.370
GR   650.530   478.980   650.420   487.060   650.630   492.430   651.060   497.830   651.350   516.030
GR   651.650   531.540   652.090   542.130   653.070   552.760   653.860   563.920   654.440   583.340
GR   654.920   596.790   655.490   608.940   655.600   616.150   656.370   626.510   657.340   637.320
GR   658.010   647.170   658.280   655.900      .000      .000      .000      .000      .000      .000

NH     4.000      .035   553.510      .050   784.430      .032   857.010      .050  1343.510      .000
X1     3.000    63.000   780.430   866.850   595.000   575.000   590.000      .000      .000      .000
GR   657.960      .000   657.000    46.010   656.550    90.360   656.570   122.560   656.400   147.560
GR   655.650   184.750   655.160   218.260   654.800   253.600   654.480   291.330   654.340   328.970
GR   653.910   365.560   653.570   406.770   653.800   448.500   652.940   500.020   652.590   536.240
GR   652.410   553.510   652.250   561.990   652.260   590.010   651.990   631.300   651.820   665.450
GR   651.260   691.000   651.180   734.700   651.090   758.560   651.210   765.350   650.840   780.430
GR   650.600   782.700   650.260   784.430   650.370   789.590   650.060   790.930   650.020   794.950
GR   649.730   802.730   649.550   815.290   649.390   826.300   649.650   837.980   650.050   843.630
GR   650.290   857.010   650.540   862.230   651.160   866.850   651.450   878.060   651.410   892.640
GR   652.450   896.120   653.340   898.920   653.590   903.020   653.420   904.650   653.770   918.450
GR   653.820   926.440   654.160   945.100   654.160   955.850   654.420   985.560   654.740  1029.340
GR   654.720  1064.280   654.480  1092.440   654.560  1134.820   655.260  1186.420   655.400  1217.630
GR   655.510  1224.100   655.740  1227.810   655.640  1232.520   655.780  1235.370   656.070  1268.200
GR   656.400  1301.300   656.570  1330.680   658.860  1343.510      .000      .000      .000      .000

NH     4.000      .035  1048.500      .050  1092.590      .032  1217.130      .060  1401.650      .000
X1     2.000    85.000  1080.020  1236.450   480.000   395.000   395.000      .000      .000      .000
X3    10.000      .000      .000      .000      .000  1252.950   653.690      .000      .000      .000
GR   655.790      .000   655.660    10.260   655.160    47.640   654.830   104.230   654.340   142.590
GR   653.840   185.260   653.100   229.120   653.270   277.680   652.460   312.540   652.020   349.330
GR   652.120   407.100   652.060   452.240   652.190   502.640   652.490   529.290   652.920   535.830
GR   652.640   588.270   652.400   590.060   652.530   633.980   652.650   664.920   653.330   683.500
GR   653.230   699.500   652.790   729.090   652.950   761.010   652.550   805.330   652.160   844.560
1
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GR     651.830    884.890    651.890    921.730    651.660    969.850    651.560   1012.730    651.370   1048.500
GR     650.930   1058.210    651.200   1062.410    651.470   1065.240    651.400   1069.770    651.320   1080.020
GR     650.790   1092.590    650.360   1114.380    650.610   1135.940    650.240   1143.550    650.090   1148.830
GR     649.650   1155.090    649.660   1163.040    649.700   1169.910    649.650   1176.620    649.650   1183.820
GR     649.550   1186.260    649.610   1191.870    649.660   1199.940    650.070   1208.490    650.330   1217.130
GR     650.500   1223.810    651.220   1226.680    652.160   1230.460    652.850   1234.070    653.180   1236.450
GR     653.480   1245.890    653.690   1252.950    653.640   1253.830    653.690   1255.120    653.590   1256.200
GR     653.510   1257.760    653.070   1259.970    652.780   1261.320    652.280   1263.030    651.860   1265.570
GR     651.730   1266.650    651.370   1269.260    651.170   1272.500    651.350   1286.430    651.330   1301.320
GR     651.280   1315.640    651.320   1321.350    651.790   1323.020    652.770   1327.410    653.520   1354.260
GR     655.060   1358.030    654.240   1358.950    654.420   1360.270    653.370   1362.140    653.660   1380.330
GR     653.920   1392.840    655.370   1395.500    655.810   1396.850    654.730   1399.210    654.300   1401.650

NH       5.000       .035   1299.690       .040   1599.060       .032   1691.830       .070   2184.760       .035
NH    2288.500       .000       .000       .000       .000       .000       .000       .000       .000       .000
X1       1.000     82.000   1612.630   1700.040    310.000    710.000    600.000       .000       .000       .000
X3      10.000       .000       .000   1052.130    653.940   1726.060    653.080       .000       .000       .000
GR     653.870       .000    652.450    114.070    651.590    228.380    650.940    299.160    651.330    391.360
GR     651.900    483.390    652.360    513.930    652.510    558.140    652.120    585.690    652.740    635.680
GR     652.360    657.770    652.600    697.150    652.460    727.230    652.600    772.080    652.410    801.460
GR     652.800    854.080    653.100    891.610    653.540    984.270    653.940   1052.130    653.920   1079.000
GR     653.890   1107.780    653.470   1146.190    653.230   1193.660    652.520   1248.390    652.420   1299.690
GR     651.850   1340.530    651.380   1372.570    651.290   1403.460    651.040   1447.870    650.930   1487.750
GR     650.780   1540.410    650.670   1565.540    650.490   1599.060    650.300   1612.630    649.950   1617.290
GR     649.810   1621.660    649.770   1628.170    649.730   1634.020    649.610   1639.440    649.610   1649.860
GR     649.640   1655.790    649.710   1661.720    649.720   1670.770    650.020   1676.730    649.830   1684.060
GR     650.330   1691.830    650.820   1694.660    651.380   1697.750    651.800   1700.040    652.290   1717.100
GR     652.810   1722.760    653.120   1726.060    653.080   1729.790    652.830   1732.150    652.320   1733.560
GR     651.980   1734.720    651.560   1736.410    650.690   1741.480    650.820   1773.500    650.950   1803.920
GR     651.230   1843.800    651.630   1868.520    651.730   1888.620    652.140   1909.660    652.120   1928.360
GR     651.820   1956.960    651.590   1960.010    651.120   1978.760    651.720   2020.460    651.820   2040.620
GR     651.820   2066.070    651.920   2081.960    652.120   2114.360    652.120   2145.560    651.920   2163.260
GR     652.020   2184.760    652.320   2202.560    652.720   2215.160    654.050   2231.810    655.320   2247.180
GR     656.200   2268.310    657.500   2288.500       .000       .000       .000       .000       .000       .000
EJ        .000       .000       .000       .000       .000       .000       .000       .000       .000       .000
1
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    SECNO      DEPTH      CWSEL      CRIWS      WSEIK      EG         HV         HL         OLOSS   BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA   LEFT/RIGHT
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN        SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID       ENDST


 *PROF 1

 IHLEQ = 1.  THEREFORE FRICTION LOSS (HL) IS CALCULATED AS A FUNCTION OF
 PROFILE TYPE, WHICH CAN VARY FROM REACH TO REACH.  SEE DOCUMENTATION FOR
 DETAILS.

 CCHV=    .200 CEHV=    .400
 1490 NH CARD USED
 *SECNO 24.000
      24.00       2.68    651.68        .00    651.68    651.69        .00        .00        .00    650.16
        92.        51.       22.        20.      281.       41.       138.         0.         0.    649.98
        .00        .18       .53        .14      .044      .033       .069       .000    649.00     76.05
    .000102         0.        0.         0.         0         0          3        .00    716.70    792.75
0
 1490 NH CARD USED
 *SECNO 23.000
      23.00       2.56    651.74        .00       .00    651.74        .01        .05        .00    650.06
        92.        64.       28.         0.      298.       50.         0.       188.       299.    653.07
        .41        .21       .56        .00      .044      .032       .069       .000    649.18     61.26
    .000133       470.      470.       445.         0         0          0        .00    564.66    625.92
0
 1490 NH CARD USED
 *SECNO 22.000
      22.00       2.94    651.81        .00       .00    651.83        .02        .08        .00    651.67
        92.         3.       56.        33.       17.       75.       149.       302.       455.    650.22
        .63        .16       .75        .22      .035      .035       .071       .000    648.87     75.10
    .000293       305.      525.       440.         2         0          0        .00    327.21    402.30
0
 1490 NH CARD USED
 *SECNO 21.000
      21.00       2.82    651.92        .00       .00    651.93        .01        .10        .00    650.52
        92.        29.       54.         9.       66.       96.        78.       391.       555.    651.09
        .86        .44       .56        .12      .035      .041       .120       .000    649.10    248.57
    .000211       430.      410.       315.         1         0          0        .00    217.70    466.28
0
 1490 NH CARD USED
 *SECNO 20.000
      20.00       3.07    651.99        .00       .00    652.02        .03        .08        .01    650.39
        92.        22.       69.         0.       92.       78.         5.       455.       612.    651.70
        .98        .24       .89        .04      .075      .032       .150       .000    648.92    356.54
    .000308       285.      325.       315.         0         0          0        .00    159.60    516.14
0
1
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    SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS   BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA   LEFT/RIGHT
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN        SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID       ENDST


 1490 NH CARD USED
 *SECNO 19.000
      19.00       3.08    652.11        .00       .00    652.13        .02        .11        .00    650.64
        92.         5.       83.         3.       27.      117.        11.       514.       660.    650.86
       1.13        .20       .71        .29      .080      .041       .050       .000    649.03    306.14
    .000290       290.      390.       425.         2         0          0        .00    116.78    422.92
0
 1490 NH CARD USED
 *SECNO 18.000
     18.00      3.00    652.18       .00       .00    652.20       .02       .07       .00    651.05
       92.        0.       80.       12.        2.      116.       43.      555.      688.    651.04
      1.25       .24       .69       .28      .050      .037      .059      .000    649.18     76.08
   .000247      250.      265.      270.         0         0         0       .00     98.28    174.37
0
 1490 NH CARD USED
 *SECNO 17.000
     17.00      3.08    652.26       .00       .00    652.28       .02       .08       .00    651.06
       92.        3.       85.        4.       13.      134.       22.      609.      721.    650.96
      1.40       .25       .64       .16      .060      .041      .090      .000    649.18     14.94
   .000241      345.      335.      290.         0         0         0       .00    103.98    118.92
0
 CCHV=    .300 CEHV=     .500
 1490 NH CARD USED
 *SECNO 16.500
     16.50      3.05    652.38       .00       .00    652.44       .06       .14       .02    655.64
       92.        0.       92.        0.        0.       87.        0.      660.      750.    655.40
      1.51       .00      1.06       .00      .060      .032      .090      .000    649.33    133.99
   .000436      400.      400.      395.         1         0         0       .00     42.34    176.33
0
 1490 NH CARD USED
 *SECNO 16.400

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  655.40 MAX ELLC=  654.12

1
  09-13-90     11:15:04                                                                                      PAGE   13


    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      655.71 ELREA=      655.41

               BOUDREAU ROAD BRIDGE
     16.40      3.05    652.38       .00       .00    652.44       .06       .00       .00    655.71
       92.        0.       92.        0.        0.       84.        0.      660.      750.    655.41
      1.51       .00      1.10       .00      .060      .030      .090      .000    649.33    133.95
   .000555        1.        1.        1.         0         0         0       .00     40.43    176.37
0
 *SECNO 16.300

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  655.40 MAX ELLC=  654.12

     16.30      3.06    652.39       .00       .00    652.45       .06       .01       .00    655.71
       92.        0.       92.        0.        0.       84.        0.      662.      751.    655.41
      1.51       .00      1.10       .00      .060      .030      .090      .000    649.33    133.90
   .000549       24.       24.       24.         0         0         0       .00     40.51    176.41
0
 1490 NH CARD USED
 *SECNO 16.200
     16.20      3.07    652.40       .00       .00    652.46       .06       .00       .00    655.64
       92.        0.       92.        0.        0.       88.        0.      662.      751.    655.40
      1.51       .00      1.05       .00      .060      .031      .090      .000    649.33    133.89
   .000404        1.        1.        1.         0         0         0       .00     42.54    176.42
0
 CCHV=    .200 CEHV=     .400
 1490 NH CARD USED
 *SECNO 15.000
     15.00      3.58    652.49       .00       .00    652.51       .01       .04       .01    652.41
       92.        0.       72.       19.        2.      120.       99.      689.      767.    650.89
      1.60       .10       .60       .20      .050      .038      .080      .000    648.91    143.93
   .000177      170.      170.      175.         0         0         0       .00    149.37    293.30
0
 1490 NH CARD USED
 *SECNO 14.000
     14.00      3.36    652.54       .00       .00    652.57       .03       .06       .01    653.42
       92.        0.       91.        1.        0.      113.       16.      736.      798.    651.65
      1.71       .00       .81       .07      .050      .031      .150      .000    649.18     54.74
   .000222      325.      300.      215.         2         0         0       .00     94.55    149.30
0
1
  09-13-90     11:15:04                                                                                      PAGE   14


    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


 1490 NH CARD USED
 *SECNO 13.000
     13.00      3.31    652.59       .00       .00    652.61       .02       .03       .00    651.34
       92.        2.       78.       12.        7.      114.       38.      766.      817.    651.05
      1.80       .29       .68       .32      .030      .031      .042      .000    649.28    292.48
   .000123      185.      210.      210.         0         0         0       .00     88.61    381.09
0
 1490 NH CARD USED
 *SECNO 12.400

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      654.25 ELREA=      654.23

     12.40      3.24    652.61       .00       .00    652.65       .04       .04       .01    654.25
       92.        0.       92.        0.        0.      107.        0.      792.      831.    654.23
      1.86       .00       .86       .00      .030      .028      .042      .000    649.37     62.78
   .000240      190.      195.      200.         0         0         0       .00     52.62    115.40
```

```
0
 *SECNO 12.300

 3370 NORMAL BRIDGE,NRD= 16 MIN ELTRD=  654.23 MAX ELLC=  654.26

             REDWILLOW PARK FOOTBRIDGE
     12.30     3.24   652.61      .00      .00   652.65      .04      .00      .00   654.25
       92.       0.      92.       0.       0.     105.       0.     793.     831.    654.23
      1.86      .00      .87      .00     .030     .028     .042     .000   649.37    62.82
   .000246       1.       1.       1.        0        0        0     -.79    52.53   115.35
0
 *SECNO 12.200

 3370 NORMAL BRIDGE,NRD= 16 MIN ELTRD=  654.23 MAX ELLC=  654.26

     12.20     3.24   652.61      .00      .00   652.65      .04      .00      .00   654.25
       92.       0.      92.       0.       0.     105.       0.     793.     831.    654.23
      1.86      .00      .87      .00     .030     .028     .042     .000   649.37    62.82
   .000246       3.       3.       3.        0        0        0     -.79    52.54   115.35
0
 *SECNO 12.100
     12.10     3.24   652.61      .00      .00   652.65      .04      .00      .00   654.25
       92.       0.      92.       0.       0.     106.       0.     793.     831.    654.23
      1.86      .00      .87      .00     .030     .028     .042     .000   649.37    62.82
   .000243       1.       1.       1.        0        0        0      .00    52.54   115.35
0
1
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    SECNO     DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS  BANK ELEV
    Q         QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA   LEFT/RIGHT
    TIME      VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN       SSTA
    SLOPE     XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


 1490 NH CARD USED
 *SECNO 11.000
     11.00     3.56   652.68      .00      .00   652.72      .05      .07      .00   652.14
       92.       1.      91.       0.       6.      94.       0.     821.     848.    652.77
      1.94      .26      .97      .00     .030     .030     .042     .000   649.12    28.65
   .000275     275.     270.     260.        0        0        0      .00    66.69    95.35
0
 1490 NH CARD USED
 *SECNO 10.600
     10.60     3.33   652.77      .00      .00   652.85      .07      .11      .01   654.83
       92.       0.      92.       0.       0.      77.       0.     848.     863.    654.42
      2.01      .00     1.19      .00     .030     .029     .042     .000   649.44   234.02
   .000459     266.     306.     331.        1        0        0      .00    36.58   270.61
0
 CCHV=    .300 CEHV=     .500
 1490 NH CARD USED
 *SECNO 10.500
     10.50     3.37   652.81      .00      .00   652.88      .07      .04      .00   654.83
       92.       0.      92.       0.       0.      79.       0.     854.     866.    654.42
      2.03      .00     1.17      .00     .030     .029     .042     .000   649.44   233.93
   .000436      80.      80.      80.        0        0        0      .00    36.86   270.79
0
 1490 NH CARD USED
 *SECNO 10.400

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  654.90 MAX ELLC=  653.56


 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      655.20 ELREA=      654.90

            HWY. 2 BRIDGE
     10.40     3.37   652.81      .00      .00   652.89      .08      .00      .00   655.20
       92.       0.      92.       0.       0.      74.       0.     854.     866.    654.90
      2.03      .00     1.25      .00     .030     .025     .042     .000   649.44   233.98
   .000553       1.       1.       1.        0        0        0      .00    35.05   270.83
0
1
  09-13-90    11:15:04                                                                                  PAGE  16

    SECNO     DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS  BANK ELEV
    Q         QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA   LEFT/RIGHT
    TIME      VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN       SSTA
    SLOPE     XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


 *SECNO 10.300

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  654.90 MAX ELLC=  653.56


 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      655.20 ELREA=      654.90

     10.30     3.39   652.83      .00      .00   652.91      .08      .02      .00   655.20
       92.       0.      92.       0.       0.      74.       0.     857.     867.    654.90
      2.04      .00     1.24      .00     .030     .025     .042     .000   649.44   233.98
   .000542      38.      38.      38.        0        0        0      .00    35.12   270.90
0
 1490 NH CARD USED
 *SECNO 10.200
     10.20     3.41   652.85      .00      .00   652.91      .07      .00      .00   654.83
       92.       0.      92.       0.       0.      80.       0.     857.     867.    654.42
      2.04      .00     1.15      .00     .030     .029     .042     .000   649.44   233.85
   .000417       1.       1.       1.        1        0        0      .00    37.10   270.95
0
 CCHV=    .200 CEHV=     .400
 1490 NH CARD USED
 *SECNO 10.100

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      654.83 ELREA=      654.42

      10.10      3.42    652.86       .00       .00    652.93       .07       .02       .00    654.83
        92.        0.       92.        0.        0.       81.        0.      860.      869.     654.42
       2.05       .00      1.14       .00      .030      .029      .042      .000    649.44    233.79
    .000403       38.       38.       38.         0         0         0       .00     37.28    271.07
0
 1490 NH CARD USED
 *SECNO 9.600
       9.60      3.45    652.94       .00       .00    652.98       .04       .05       .01    654.04
        92.        0.       92.        0.        0.      104.        0.      876.      875.     654.04
       2.10       .00       .89       .00      .030      .030      .042      .000    649.49    178.58
    .000207      185.      175.      170.         0         0         0       .00     40.16    218.74
0
1
  09-13-90     11:15:04                                                                                      PAGE  17

     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN        SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

 CCHV=    .300 CEHV=     .500
 1490 NH CARD USED
 *SECNO 9.500

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      654.04 ELREA=      654.04

       9.50      3.46    652.95       .00       .00    652.99       .04       .00       .00    654.04
        92.        0.       92.        0.        0.      104.        0.      878.      876.     654.04
       2.11       .00       .88       .00      .030      .030      .042      .000    649.49    178.56
    .000204       20.       20.       20.         0         0         0       .00     40.20    218.76
0
 1490 NH CARD USED
 *SECNO 9.400

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  654.60 MAX ELLC=  653.40


 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      654.62 ELREA=      654.30

               PERRON STREET BRIDGE
       9.40      3.45    652.94       .00       .00    652.99       .05       .00       .00    654.62
        92.        0.       92.        0.        0.       96.        0.      878.      876.     654.30
       2.11       .00       .96       .00      .030      .031      .042      .000    649.49    179.49
    .000389        1.        1.        1.         0         0         0       .07     34.95    216.24
0
 *SECNO 9.300

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  654.60 MAX ELLC=  653.40


 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      654.62 ELREA=      654.30

       9.30      3.46    652.95       .00       .00    653.00       .05       .01       .00    654.62
        92.        0.       92.        0.        0.       96.        0.      880.      877.     654.30
       2.12       .00       .96       .00      .030      .031      .042      .000    649.49    179.49
    .000388       20.       20.       20.         0         0         0       .00     34.95    216.24
0
1
  09-13-90     11:15:04                                                                                      PAGE  18

     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN        SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

 1490 NH CARD USED
 *SECNO 9.200
       9.20      3.47    652.96       .00       .00    653.00       .04       .00       .00    654.04
        92.        0.       92.        0.        0.      104.        0.      881.      877.     654.04
       2.12       .00       .88       .00      .030      .030      .042      .000    649.49    178.55
    .000203        5.        5.        5.         0         0         0       .00     40.22    218.77
0
 *SECNO 9.100
       9.10      3.48    652.97       .00       .00    653.01       .04       .01       .00    654.04
        92.        0.       92.        0.        0.      105.        0.      885.      879.     654.04
       2.13       .00       .87       .00      .030      .030      .042      .000    649.49    178.52
    .000198       38.       38.       38.         0         0         0       .00     40.29    218.81
0
 1490 NH CARD USED
 *SECNO 8.000

 3470 ENCROACHMENT STATIONS=        .0     157.3  TYPE=     1  TARGET=     157.269

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      651.31 ELREA=      654.71

       8.00      3.50    653.03       .00       .00    653.05       .01       .03       .01    651.31
        92.       18.       74.        0.       55.      132.        0.      923.      897.     654.71
       2.27       .32       .56       .00      .030      .030      .042      .000    649.53     49.23
    .000075      255.      260.      260.         0         0         0       .00     98.19    147.42
0
 1490 NH CARD USED
 *SECNO 7.000
 3470 ENCROACHMENT STATIONS=         .0     142.9  TYPE=     1  TARGET=     142.869

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      653.94 ELREA=      654.56

            REDWILLOW PARK FOOTBRIDGE
      7.00     3.65   653.04      .00       .00   653.08      .04      .02      .01   653.94
       92.       0.      92.       0.        0.     111.       0.     949.     909.    654.56
      2.33      .00      .83      .00      .030     .029     .042     .000   649.39     87.90
   .000194     180.     175.     185.         1        0        0      .00    47.86    135.77
0
1
  09-13-90     11:15:04                                                                                     PAGE  19

    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


 1490 NH CARD USED
 *SECNO 6.500
      6.50     3.95   653.09      .00       .00   653.10      .02      .02      .01   660.46
       92.       0.      92.       0.        0.     165.       0.     972.     919.    660.96
      2.41      .00      .56      .00      .030     .033     .042     .000   649.14     17.94
   .000091     172.     172.     167.         2        0        0      .00    59.94     77.88
0
 1490 NH CARD USED
 *SECNO 6.400

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  660.27 MAX ELLC=  658.60

            C.N.R. BRIDGE
      6.40     3.94   653.08      .00       .00   653.12      .04      .00      .01   660.46
       92.       0.      92.       0.        0.     106.       0.     973.     919.    660.96
      2.42      .00      .87      .00      .030     .031     .042     .000   649.14     17.88
   .000350       1.       1.       1.         1        0        0      .00    35.65     77.82
0
 1490 NH CARD USED
 *SECNO 6.300

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  660.27 MAX ELLC=  658.60

      6.30     3.94   653.08      .00       .00   653.12      .04      .00      .00   660.46
       92.       0.      92.       0.        0.     106.       0.     973.     919.    660.96
      2.42      .00      .87      .00      .030     .031     .042     .000   649.14     17.89
   .000351       7.       7.       7.         0        0        0      .00    35.64     77.81
0
 1490 NH CARD USED
 *SECNO 6.200
      6.20     3.97   653.11      .00       .00   653.12      .02      .00      .01   660.46
       92.       0.      92.       0.        0.     166.       0.     973.     919.    660.96
      2.42      .00      .55      .00      .030     .033     .042     .000   649.14     17.90
   .000089       1.       1.       1.         2        0        0      .00    60.02     77.91
0
1
  09-13-90     11:15:04                                                                                     PAGE  20

    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


 1490 NH CARD USED
 *SECNO 5.000
      5.00     3.70   653.14      .00       .00   653.14      .00      .01      .00   650.58
       92.      26.      63.       3.      220.     208.      35.    1092.     986.    651.97
      2.85      .12      .30      .09      .054     .034     .049     .000   649.44    113.67
   .000024     370.     380.     390.         2        0        0      .00   295.27    408.94
0
 1490 NH CARD USED
 *SECNO 4.000
      4.00     3.50   653.15      .00       .00   653.15      .00      .01      .00   650.83
       92.      31.      58.       2.      363.     336.      81.    1465.    1190.    651.06
      4.03      .09      .17      .03      .050     .035     .150     .000   649.65    170.06
   .000008     600.     600.     605.         2        0        0      .00   383.83    553.89
0
 1490 NH CARD USED
 *SECNO 3.000
      3.00     3.77   653.16      .00       .00   653.16      .00      .01      .00   650.84
       92.      30.      57.       5.      365.     278.      51.    1900.    1425.    651.16
      5.07      .08      .20      .09      .049     .033     .050     .000   649.39    486.86
   .000010     595.     590.     575.         0        0        0      .00   411.50    898.35
0
 1490 NH CARD USED
 *SECNO 2.000

 3265 DIVIDED FLOW


 3470 ENCROACHMENT STATIONS=         .0    1252.9  TYPE=     1  TARGET=    1252.949

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      651.32 ELREA=      653.18

      2.00     3.61   653.16      .00       .00   653.16      .00      .00      .00   651.32
       92.      41.      51.       0.      717.     442.       0.    2313.    1740.    653.18
      6.39      .06      .12      .00      .036     .033     .050     .000   649.55    225.62
   .000004     480.     395.     395.         0        0        0      .00   948.78   1236.30
0
 1490 NH CARD USED
 *SECNO 1.000
1
  09-13-90     11:15:04                                                                                        PAGE   21

     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


 3470 ENCROACHMENT STATIONS=     1052.1     1726.1  TYPE=      1  TARGET=      673.930
  ELENCL=     653.94  ELENCR=    653.08
      1.00      3.55    653.16       .00       .00    653.16       .00       .00       .00    650.30
       92.       54.       37.        1.      682.      284.       63.     2770.     2183.    651.80
      7.65       .08       .13       .01      .039      .033      .069      .000    649.61   1198.87
   .000004      310.      600.      710.         0         0         0       .00   1017.71   2216.57
0
1
  09-13-90     11:15:04                                                                                        PAGE   22


 **************************************************                             THIS RUN EXECUTED 09-13-90
   HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
   ERROR CORR -  01,02,03,04,05,06
   MODIFICATION -  50,51,52,53,54,55,56
   IBM-PC-XT VERSION AUGUST 1985
 **************************************************

 NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

 eon River at St.Albert

 SUMMARY PRINTOUT


       SECNO      CWSEL        Q        XLCH      K*XNL     K*XNCH     K*XNR      QLOB       QCH      QROB      IHLEQ       HV

      24.000     651.68     92.00       .00      44.08      32.62      69.38     50.68     21.64     19.68      2.00       .00
      23.000     651.74     92.00    470.00      43.61      32.16      69.38     64.00     28.01       .00      2.00       .01
      22.000     651.81     92.00    525.00      35.00      35.38      70.89      2.76     55.81     33.43      3.00       .02
      21.000     651.92     92.00    410.00      35.00      41.19     120.00     28.88     53.76      9.36      4.00       .01
      20.000     651.99     92.00    325.00      75.18      31.72     150.00     22.46     69.33       .21      3.00       .03
      19.000     652.11     92.00    390.00      80.00      40.57      50.00      5.43     83.46      3.12      4.00       .02
      18.000     652.18     92.00    265.00      50.00      37.28      58.93       .39     79.74     11.87      4.00       .02
      17.000     652.26     92.00    335.00      60.00      40.83      90.00      3.39     85.06      3.55      4.00       .02
      16.500     652.38     92.00    400.00      60.00      31.54      90.00       .00     92.00       .00      2.00       .06
      16.400     652.38     92.00      1.00      60.00      30.38      90.00       .00     92.00       .00      3.00       .06
      16.300     652.39     92.00     24.00      60.00      30.39      90.00       .00     92.00       .00      4.00       .06
      16.200     652.40     92.00      1.00      60.00      30.81      90.00       .00     92.00       .00      4.00       .06
      15.000     652.49     92.00    170.00      50.00      38.21      80.00       .17     72.47     19.36      4.00       .01
      14.000     652.54     92.00    300.00      50.00      30.92     150.00       .00     90.96      1.04      2.00       .03
      13.000     652.59     92.00    210.00      30.00      30.96      41.98      2.14     77.90     11.96      4.00       .02
      12.400     652.61     92.00    195.00      30.00      28.37      41.98       .00     92.00       .00      2.00       .04
      12.300     652.61     92.00      1.00      30.00      28.44      41.98       .00     92.00       .00      3.00       .04
      12.200     652.61     92.00      3.00      30.00      28.44      41.98       .00     92.00       .00      4.00       .04
      12.100     652.61     92.00      1.00      30.00      28.37      41.98       .00     92.00       .00      4.00       .04
      11.000     652.68     92.00    270.00      30.00      29.53      41.98      1.47     90.53       .00      3.00       .05
      10.600     652.77     92.00    306.00      30.00      28.82      41.98       .00     92.00       .00      2.00       .07
      10.500     652.81     92.00     80.00      30.00      28.82      41.98       .00     92.00       .00      4.00       .07
      10.400     652.81     92.00      1.00      30.00      25.04      41.98       .00     92.00       .00      3.00       .08
      10.300     652.83     92.00     37.90      30.00      25.02      41.98       .00     92.00       .00      4.00       .08
      10.200     652.85     92.00      1.00      30.00      28.82      41.98       .00     92.00       .00      4.00       .07
      10.100     652.86     92.00     38.00      30.00      28.82      41.98       .00     92.00       .00      4.00       .07
       9.600     652.94     92.00    175.00      30.00      29.76      41.98       .00     92.00       .00      4.00       .04
       9.500     652.95     92.00     20.00      30.00      29.76      41.98       .00     92.00       .00      4.00       .04
       9.400     652.94     92.00      1.00      30.00      31.20      41.98       .00     92.00       .00      3.00       .05
       9.300     652.95     92.00     19.60      30.00      31.20      41.98       .00     92.00       .00      4.00       .05
       9.200     652.96     92.00      5.00      30.00      29.76      41.98       .00     92.00       .00      4.00       .04
       9.100     652.97     92.00     38.00      30.00      29.76      41.98       .00     92.00       .00      4.00       .04
       8.000     653.03     92.00    260.00      30.00      29.97      41.98     17.70     74.30       .00      4.00       .01
       7.000     653.04     92.00    175.00      30.00      28.96      41.98       .00     92.00       .00      3.00       .04
       6.500     653.09     92.00    172.00      30.00      33.12      41.98       .00     92.00       .00      4.00       .02
       6.400     653.08     92.00      1.00      30.00      30.60      41.98       .00     92.00       .00      3.00       .04
       6.300     653.08     92.00      6.70      30.00      30.60      41.98       .00     92.00       .00      3.00       .04
       6.200     653.11     92.00      1.00      30.00      33.13      41.98       .00     92.00       .00      4.00       .02
       5.000     653.14     92.00    380.00      54.09      33.78      49.39     25.73     63.00      3.28      4.00       .00
       4.000     653.15     92.00    600.00      49.88      34.63     150.00     31.41     58.46      2.13      4.00       .00
       3.000     653.16     92.00    590.00      49.27      33.13      50.00     30.48     56.98      4.55      3.00       .00
       2.000     653.16     92.00    395.00      36.28      32.82      50.00     40.81     51.19       .00      4.00       .00
       1.000     653.16     92.00    600.00      39.14      32.54      68.94     53.75     37.37       .88      2.00       .00
1


 SUMMARY OF ERRORS AND SPECIAL NOTES

1
 09-13-90     11:16:40                                                                                         PAGE    1


 **************************************************                             THIS RUN EXECUTED 09-13-90
   HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
   ERROR CORR -  01,02,03,04,05,06
   MODIFICATION -  50,51,52,53,54,55,56
   IBM-PC-XT VERSION AUGUST 1985
 **************************************************
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1*****************************************************                    ************************************
 *   WATER SURFACE PROFILES                              *                  *  U.S. ARMY CORPS OF ENGINEERS
 *                                                                         *  THE HYDROLOGIC ENGINEERING CENTER
 *   VERSION OF NOVEMBER 1976                            *                  *  609 SECOND STREET, SUITE D
 *                                                                          *  DAVIS, CALIFORNIA 95616
 *   UPDATED MAY 1984                                    *                   *  (916) 440-2105 (FTS) 448-2105
 *                                                                        ************************************
 *   IBM-PC-XT VERSION AUGUST 1985                       *
 *
 *   RUN DATE  09-11-90   TIME  15:39:07                 *
*
 *****************************************************


                         X     X  XXXXXXX  XXXXX           XXXXX
                         X     X  X       X     X         X     X
                         X     X  X       X                     X
                         XXXXXXX  XXXX    X        XXXXX   XXXXX
                         X     X  X       X               X
                         X     X  X       X     X         X
                         X     X  XXXXXXX  XXXXX          XXXXXXX
1
 09-11-90     15:39:08                                                                        PAGE    1


                                                                   THIS RUN EXECUTED 09-11-90
 ***************************************************
   HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
   ERROR CORR -  01,02,03,04,05,06
   MODIFICATION -  50,51,52,53,54,55,56
   IBM-PC-XT VERSION AUGUST 1985
 ***************************************************


 C
 T1      Sturgeon River at St. Albert   1/100 encroached-to-floodway  Q=92m3/s
 T2      1989/90 FDR study                   ******** final run ********
 T3      input filename - STURGEON.IN     output filename - STURGEON.OUT

 J1  ICHECK     INQ      NINV      IDIR      STRT     METRIC    HVINS     Q        WSEL      FQ

      -1.        0.        0.        0.   .000100     1.00        .0     92.   651.680     .000

 J2  NPROF     IPLOT    PRFVS     XSECV     XSECH      FN      ALLDC     IBW      CHNIM     ITRACE

     -1.000     .000   -1.000      .000      .000      .000   -1.000      .000      .000    15.000

 J3  VARIABLE CODES FOR SUMMARY PRINTOUT

     38.000    1.000    2.000    3.000    39.000    16.000    17.000    18.000    13.000    14.000

     15.000     .000     .000     .000      .000      .000      .000      .000      .000      .000

 J6  IHLEQ     ICOPY

      1.000     .000     .000     .000      .000      .000      .000      .000      .000      .000


 NC       .000      .000      .000       .200       .400       .000       .000       .000       .000       .000
 NH      6.000      .100    36.040       .035    239.150       .045    577.070       .032    594.020       .070
 NH    761.420      .035  1177.540       .000       .000       .000       .000       .000       .000       .000
 X1     24.000    45.000   577.070    595.070       .000       .000       .000       .000       .000       .000
 X3     10.000      .000      .000    400.000       .000    700.000       .000       .000       .000       .000
 GR    655.930      .000   655.320      1.590    654.540      2.600    653.380     15.290    652.640     36.040
 GR    651.540    82.050   651.400    132.910    651.450    194.550    651.330    239.150    650.980    275.300
 GR    650.920   335.230   650.850    389.640    650.880    439.740    651.000    496.220    651.610    537.860
 GR    651.260   550.940   650.920    556.980    650.290    562.420    650.000    568.550    650.110    573.060
 GR    650.160   577.070   649.880    578.750    649.280    580.670    649.000    583.460    649.110    585.970
 GR    649.230   589.350   649.540    591.540    649.870    594.020    649.980    595.070    649.920    610.570
 GR    650.070   622.620   651.040    628.540    650.880    662.040    650.780    682.430    651.110    695.240
 GR    651.230   722.900   651.400    761.420    651.700    794.570    651.900    838.990    652.440    890.920
 GR    653.370   942.990   654.420    985.800    655.260   1043.060    656.290   1108.810    658.320   1177.540

 NH      6.000      .100   119.310       .035    346.510       .050    593.360       .032    619.630       .150
 NH    683.070      .035   786.380       .000       .000       .000       .000       .000       .000       .000
1
 09-11-90     15:39:08                                                                        PAGE    2

 X1     23.000    31.000   600.390    632.140    470.000    445.000    470.000       .000       .000       .000
 X3     10.000      .000      .000    360.000       .000       .000       .000       .000       .000       .000
 GR    650.900   136.500   651.000    384.500    651.200    419.000    651.000    447.100    650.800    466.000
 GR    651.000   480.000   651.200    490.000    651.000    500.000    650.500    527.060    650.840    561.270
 GR    650.030   593.360   650.060    600.390    649.940    601.710    649.410    603.310    649.350    608.090
 GR    649.180   611.040   649.180    613.000    649.240    614.880    649.530    617.350    649.930    619.630
 GR    650.700   622.790   651.800    626.130    653.070    632.140    653.760    645.810    654.320    661.060
 GR    654.560   672.780   654.800    683.070    655.040    692.360    655.810    725.850    656.940    757.280
 GR    658.670   786.380      .000       .000       .000       .000       .000       .000       .000       .000

 NH      4.000      .035   175.320       .032    193.970       .050    267.280       .150    469.170       .000
 X1     22.000    26.000   173.130    211.080    305.000    440.000    525.000       .000       .000       .000
 X3     10.000      .000      .000    100.000       .000    335.000       .000       .000       .000       .000
 GR    655.900      .000   654.070     14.190    652.630     36.750    651.860     69.090    651.550    110.370
 GR    651.620   144.560   651.670    173.130    651.550    174.270    650.630    175.320    649.950    176.090
 GR    649.460   176.850   648.870    180.080    649.060    183.930    649.430    186.680    649.860    189.160
 GR    649.940   193.970   650.220    211.080    650.360    214.230    650.500    216.350    650.700    242.910
 GR    650.640   267.280   651.220    283.340    651.060    330.570    651.390    384.140    652.360    425.610
 GR    653.160   469.170      .000       .000       .000       .000       .000       .000       .000       .000

 NH      4.000      .035   337.650       .032    360.450       .120    498.950       .035    588.250       .000
```

```
X1    21.000    52.000   334.950   382.750   430.000   315.000   410.000      .000      .000      .000
X3    10.000      .000      .000   230.000      .000   475.000      .000      .000      .000      .000
GR   656.020      .000   654.980    30.380   653.890    68.500   653.490    93.190   653.540   101.270
GR   652.900   132.100   652.590   156.780   652.270   185.710   652.310   225.260   651.610   265.850
GR   651.490   286.180   651.310   294.150   650.620   305.350   650.430   318.150   650.470   324.150
GR   650.520   334.950   650.260   337.650   650.010   339.350   649.870   340.550   649.590   341.050
GR   649.480   345.350   649.280   349.850   649.100   354.950   649.160   357.050   649.340   358.150
GR   649.860   359.250   649.970   360.450   650.050   361.350   650.110   371.950   650.270   377.250
GR   650.910   380.150   651.010   381.850   651.090   382.750   650.930   397.850   650.880   411.650
GR   650.740   423.650   650.760   439.550   650.960   442.750   651.160   456.450   651.520   462.450
GR   652.250   469.650   652.500   472.750   652.010   485.850   653.100   498.950   653.170   516.350
GR   653.390   530.150   653.910   544.050   654.450   556.150   654.840   562.750   655.130   570.350
GR   655.280   580.950   655.480   588.250      .000      .000      .000      .000      .000      .000

NH     6.000      .035   350.940      .120   423.210      .050   448.260      .032   477.080      .150
NH   538.900      .035   635.130      .000      .000      .000      .000      .000      .000      .000
X1    20.000    52.000   448.260   486.270   285.000   315.000   325.000      .000      .000      .000
X3    10.000      .000      .000   330.000      .000      .000      .000      .000      .000      .000
GR   659.010      .000   657.220    23.570   655.550    47.610   654.780    70.060   653.310    97.880
GR   652.740   127.620   652.560   142.690   652.560   160.680   652.720   162.790   652.500   194.570
GR   652.210   234.830   652.300   274.870   652.480   300.520   652.910   323.700   653.200   332.200
GR   653.050   350.940   652.290   355.440   651.800   357.270   650.970   381.230   650.960   401.940
GR   650.940   423.210   650.720   432.490   650.580   439.310   650.390   448.260   650.330   449.650
GR   650.210   451.850   650.070   453.530   649.890   456.430   649.500   459.130   649.380   462.110
GR   649.070   466.540   648.920   470.440   649.260   473.860   649.870   475.330   649.960   475.760
GR   650.360   477.080   651.060   481.140   651.700   486.270   651.770   492.750   651.880   513.650
GR   652.480   526.560   653.150   529.120   654.000   534.640   654.450   537.260   654.950   538.900
GR   655.790   545.200   656.060   548.020   656.690   566.020   657.190   595.600   657.320   614.240
GR   657.600   629.620   657.810   635.130      .000      .000      .000      .000      .000      .000
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                                                                                              PAGE     3

NH     6.000      .035   253.140      .080   373.330      .032   394.330      .050   423.330      .100
NH   431.930      .035   488.450      .000      .000      .000      .000      .000      .000      .000
X1    19.000    43.000   355.330   408.230   290.000   425.000   390.000      .000      .000      .000
X3    10.000      .000      .000   317.000      .000      .000      .000      .000      .000      .000
GR   672.590      .000   671.400    32.540   669.540    55.320   667.440    76.410   665.080    97.360
GR   662.750   116.930   660.640   133.630   658.300   155.200   656.370   186.170   653.900   228.140
GR   653.320   253.140   652.110   272.430   652.390   287.810   651.950   316.380   651.970   328.860
GR   651.240   339.850   650.950   345.330   650.640   355.330   650.170   365.330   649.920   370.330
GR   650.010   373.330   649.860   373.730   649.410   379.630   649.210   382.030   649.030   385.930
GR   649.160   387.930   649.410   391.330   649.860   394.330   650.020   398.830   650.270   404.330
GR   650.860   408.230   651.360   414.330   651.640   421.030   652.210   423.330   653.400   428.630
GR   654.610   431.930   655.070   436.330   655.170   437.570   660.750   458.390   660.720   477.720
GR   660.860   486.620   660.900   488.110   660.730   488.450      .000      .000      .000      .000

NH     6.000      .035    36.150      .100    69.910      .050    84.200      .032   108.900      .070
NH   165.100      .030   315.770      .000      .000      .000      .000      .000      .000      .000
X1    18.000    48.000    78.700   133.700   250.000   270.000   265.000      .000      .000      .000
GR   666.980      .000   665.800    15.780   664.460    36.150   663.490    53.110   662.060    58.550
GR   660.460    62.270   658.690    65.540   656.320    69.910   653.800    73.090   651.660    77.060
GR   651.050    78.700   650.490    82.700   650.080    84.200   649.910    85.500   649.470    88.900
GR   649.270    90.600   649.180    92.900   649.270    98.200   649.390   101.200   649.540   103.400
GR   649.620   105.700   649.910   108.900   650.140   113.600   650.400   118.200   650.860   125.800
GR   651.060   129.320   651.040   133.700   651.090   146.690   651.020   151.400   651.100   165.100
GR   651.580   173.100   651.840   173.880   652.760   175.170   653.050   175.900   653.200   176.570
GR   653.220   178.230   653.890   188.690   654.200   214.080   654.490   237.700   654.670   257.380
GR   654.630   270.890   654.890   289.050   655.080   305.610   655.120   307.050   654.980   307.430
GR   654.920   311.230   654.910   315.480   655.000   315.770      .000      .000      .000      .000

NH     5.000      .100    15.210      .060    44.500      .032    68.300      .090   129.250      .030
NH   356.090      .000      .000      .000      .000      .000      .000      .000      .000      .000
X1    17.000    43.000    29.960    91.500   345.000   290.000   335.000      .000      .000      .000
GR   663.260      .000   661.980     2.150   658.400     6.640   655.960     9.890   653.580    13.040
GR   652.080    15.210   651.320    20.040   651.060    29.960   650.430    35.500   650.170    40.500
GR   650.120    44.500   649.950    45.500   649.750    46.800   649.450    49.900   649.200    53.500
GR   649.180    58.100   649.400    63.200   649.570    66.000   649.950    68.300   650.190    69.800
GR   650.370    74.500   650.700    83.400   650.960    91.500   651.250   100.700   651.670   109.500
GR   651.860   117.200   652.310   119.100   653.330   125.700   654.130   129.250   654.460   132.060
GR   654.310   147.300   653.750   184.720   653.900   220.640   654.370   263.520   654.580   287.060
GR   655.390   306.240   655.640   330.080   655.690   346.350   655.800   348.250   655.610   348.700
GR   655.580   351.660   655.580   355.140   655.700   356.090      .000      .000      .000      .000

NC      .000      .000      .000      .300      .500      .000      .000      .000      .000      .000
NH     3.000      .080   143.220      .032   166.620      .070   352.440      .000      .000      .000
X1    16.500    30.000   123.650   187.750   400.000   395.000   400.000      .000      .000      .000
GR   656.380      .000   656.180      .010   656.300    35.500   656.170    74.230   655.890   114.310
GR   655.640   123.650   655.280   124.620   653.700   128.720   652.490   133.420   651.460   138.420
GR   650.430   143.220   649.960   143.820   649.760   144.820   649.480   149.420   649.510   154.320
GR   649.360   157.020   649.330   160.120   649.330   161.820   649.960   166.620   650.310   168.320
GR   651.140   171.420   652.820   178.120   653.880   182.620   655.100   186.420   655.400   187.750
GR   655.530   218.580   655.550   253.500   655.810   286.360   656.240   317.090   656.840   352.440
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                                                                                              PAGE     4

NH     3.000      .025   138.420      .032   171.420      .025   230.000      .000      .000      .000
            BOUDREAU ROAD BRIDGE
X1    16.400    29.000   128.720   182.622     1.000     1.000     1.000      .000      .000      .000
X2      .000      .000      .000   654.120   655.400      .000      .000      .000      .000      .000
X3    10.000      .000      .000      .000      .000      .000      .000      .000      .000      .000
GR   655.890   114.310   655.710   128.720   654.420   128.721   653.700   128.722   652.490   133.420
GR   651.460   138.420   650.430   142.720   654.310   142.721   654.310   143.720   650.430   143.721
GR   649.960   143.820   649.760   144.820   649.480   149.420   649.510   154.320   649.360   157.020
GR   649.330   160.120   649.330   161.820   649.960   166.620   650.310   167.820   654.210   167.821
GR   654.210   168.820   650.310   168.821   651.140   171.420   652.820   178.120   653.880   182.620
GR   654.120   182.621   655.410   182.622   655.390   200.000   655.320   230.000      .000      .000

X1    16.300      .000      .000      .000    24.000    24.000    24.000      .000      .000      .000
X2      .000      .000      .000   654.120   655.400      .000      .000      .000      .000      .000

NH     3.000      .040   143.220      .032   166.620      .070   352.440      .000      .000      .000
X1    16.200    30.000   123.650   187.750     1.000     1.000     1.000      .000      .000      .000
GR   656.380      .000   656.180      .010   656.300    35.500   656.170    74.230   655.890   114.310
GR   655.640   123.650   655.280   124.620   653.700   128.720   652.490   133.420   651.460   138.420
GR     650.430   143.220   649.960   143.820   649.760   144.820   649.480   149.420   649.510   154.320
GR     649.360   157.020   649.330   160.120   649.330   161.820   649.960   166.620   650.310   168.320
GR     651.140   171.420   652.820   178.120   653.880   182.620   655.100   186.420   655.400   187.750
GR     655.530   218.580   655.550   253.500   655.810   286.360   656.240   317.090   656.840   352.440

NC        .000      .000      .000      .200      .400      .000      .000      .000      .000      .000
NH       3.000      .050   159.740      .032   182.040      .080   323.680      .000      .000      .000
X1      15.000    55.000   151.230   203.740   170.000   175.000   170.000      .000      .000      .000
GR     662.520      .000   662.050     3.810   661.160     7.510   660.700    10.510   660.060    13.170
GR     659.280    15.750   658.790    19.570   658.050    25.300   657.110    36.420   656.670    43.020
GR     656.580    47.830   656.800    51.240   656.770    61.900   656.770    69.070   657.290    71.600
GR     656.710    78.120   656.000    84.050   655.100    93.630   654.360   103.540   653.740   113.640
GR     652.940   137.400   652.030   150.400   652.410   151.230   652.330   151.740   651.280   155.740
GR     650.780   158.740   650.260   159.740   649.960   160.740   649.660   162.940   649.360   164.940
GR     648.910   169.340   649.210   172.140   649.480   174.740   649.590   177.340   649.610   179.240
GR     649.960   182.040   650.250   183.740   650.330   188.440   650.480   195.740   650.890   203.740
GR     650.860   210.740   650.840   221.740   650.780   234.140   651.120   237.580   651.260   240.740
GR     651.690   266.870   652.210   290.560   653.190   300.410   654.170   306.110   654.570   307.240
GR     655.000   308.700   655.450   311.320   655.680   315.740   655.800   319.340   655.640   323.680

NH       3.000      .030    74.800      .032   100.900      .150   356.340      .000      .000      .000
X1      14.000    46.000    45.500   106.400   325.000   215.000   300.000      .000      .000      .000
GR     656.360      .000   655.790     3.500   655.060     7.300   654.460    10.300   654.010    13.200
GR     653.830    20.800   653.680    29.200   653.560    37.400   653.420    45.500   653.000    50.700
GR     652.510    55.000   652.100    58.800   651.580    62.300   650.850    67.300   650.390    69.800
GR     650.120    74.800   649.980    80.300   649.680    82.700   649.430    87.400   649.180    91.500
GR     649.180    95.400   649.580    99.500   649.980   100.900   650.060   101.000   650.510   101.500
GR     650.840   104.600   651.200   105.100   651.650   106.400   651.590   108.900   652.080   118.250
GR     652.200   125.930   652.400   139.890   652.660   157.420   652.640   176.000   653.900   192.460
GR     653.230   205.550   653.740   213.650   655.060   220.350   654.630   224.760   654.430   227.500
GR     654.560   233.960   654.430   245.920   654.590   269.620   654.700   290.210   655.020   320.800
GR     655.420   356.340      .000      .000      .000      .000      .000      .000      .000      .000
1
  09-11-90     15:39:08                                                                            PAGE     5


NH       4.000      .030   312.710      .032   340.910      .030   363.210      .070   487.560      .000
X1      13.000    44.000   307.710   351.010   185.000   210.000   210.000      .000      .000      .000
GR     658.720      .000   658.740     1.510   657.500     6.520   657.020     9.320   655.790    37.220
GR     654.940    73.010   654.460   124.310   654.840   162.190   654.780   204.930   654.080   251.790
GR     653.030   283.200   652.490   294.330   652.320   297.710   651.970   302.710   651.340   307.710
GR     650.070   312.710   650.000   313.910   649.550   316.810   649.350   318.510   649.280   324.410
GR     649.500   329.010   649.800   335.510   650.000   340.910   650.060   343.810   650.400   345.010
GR     650.780   347.510   651.050   351.010   651.210   363.210   651.340   375.810   651.950   378.810
GR     653.000   382.610   653.770   385.110   654.590   389.710   655.150   391.940   655.200   409.830
GR     655.040   425.000   655.140   430.000   655.080   434.570   655.290   445.070   655.420   451.840
GR     655.420   465.290   655.690   474.050   655.870   481.400   656.030   487.560      .000      .000

NH       3.000      .030    75.830      .032    98.630      .030   148.970      .000      .000      .000
X1      12.400    25.000    54.830   123.830   190.000   200.000   195.000      .000      .000      .000
X3      10.000      .000      .000      .000      .000      .000      .000      .000      .000      .000
GR     654.310      .000   654.200     4.120   654.310    21.750   654.510    21.750   654.600    41.330
GR     654.330    52.100   654.250    54.830   652.200    64.830   652.200    64.840   651.740    68.830
GR     650.930    73.830   650.140    75.830   649.370    81.430   649.370    84.430   649.490    92.930
GR     649.940    95.830   650.020    98.630   650.670   103.030   651.380   108.030   651.910   114.230
GR     652.400   114.240   654.230   123.830   654.130   132.120   653.980   138.460   653.680   148.970

              REDWILLOW PARK FOOTBRIDGE
X1      12.300      .000      .000      .000     1.000     1.000     1.000      .000      .000      .000
BT     -16.000    54.830   654.250   654.250    64.830   654.640   652.200    64.840   654.640   652.390
BT        .000    68.830   654.800   653.200    73.830   654.930   653.750    75.830   655.000   653.900
BT        .000    81.430   655.060   654.140    84.430   655.080   654.220    92.930   655.080   654.260
BT        .000    95.830   655.070   654.240    98.630   655.050   654.150   103.030   655.000   653.930
BT        .000   108.030   654.870   653.440   114.230   654.670   652.400   114.240   654.670   652.400
BT        .000   123.830   654.230   654.230      .000      .000      .000      .000      .000      .000

X1      12.200      .000      .000      .000     3.000     3.000     3.000      .000      .000      .000
X2        .000      .000      .000      .000      .000      .000     1.000      .000      .000      .000

X1      12.100      .000      .000      .000     1.000     1.000     1.000      .000      .000      .000

NH       3.000      .030    64.650      .032    87.450      .060   119.650      .000      .000      .000
X1      11.000    28.000    54.650    95.650   275.000   260.000   270.000      .000      .000      .000
GR     654.460      .000   653.900     5.150   653.140    15.470   652.650    29.480   652.510    44.390
GR     652.380    44.650   652.140    54.650   651.690    59.650   651.250    61.650   650.190    64.650
GR     650.070    65.450   649.720    67.350   649.570    70.550   649.120    75.550   649.320    78.950
GR     649.420    83.550   650.070    87.450   650.660    88.650   651.280    90.650   651.930    92.850
GR     652.770    95.650   653.210    97.650   653.550   101.520   653.990   105.840   654.670   110.170
GR     655.650   115.320   656.270   118.060   656.760   119.650      .000      .000      .000      .000

NH       3.000      .030   245.980      .032   259.880      .030   480.520      .000      .000      .000
X1      10.600    59.000   229.190   275.980   266.000   331.000   306.000      .000      .000      .000
GR     656.050      .000   655.820      .010   656.050    16.950   655.770    31.190   655.910    31.191
GR     655.910    59.570   655.820    82.710   655.700    93.890   655.500    96.120   655.400   104.780
GR     655.300   104.781   655.590   136.840   655.170   160.050   655.070   160.051   655.200   175.160
GR     654.860   188.590   655.070   188.591   655.160   193.090   655.050   213.310   655.080   223.460
GR     654.830   229.190   654.550   229.970   652.780   233.980   651.690   237.180   651.220   240.480
GR     651.020   240.580   650.350   242.580   650.230   243.980   650.080   245.980   650.060   246.180
GR     650.010   246.380   649.760   247.980   649.440   250.380   649.610   251.980   649.510   256.880
1
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GR     649.830   258.680   650.060   259.880   650.890   262.680   651.220   263.780   651.290   267.680
GR     652.160   267.780   652.910   271.280   653.760   273.880   654.420   275.980   654.510   282.000
GR     654.500   293.950   654.150   316.370   653.710   344.590   653.480   357.570   653.350   357.571
GR     653.330   375.130   653.680   385.050   653.700   395.410   653.550   406.250   653.680   406.251
GR     654.090   423.310   654.890   442.730   655.620   460.150   656.480   480.520      .000      .000

NC        .000      .000      .000      .300      .500      .000      .000      .000      .000      .000
NH       3.000      .030   245.980      .032   259.880      .030   480.520      .000      .000      .000
X1      10.500      .000      .000      .000    80.000    80.000    80.000      .000      .000      .000

NH       3.000      .020   245.930      .032   259.880      .020   271.281      .000      .000      .000
              HWY. 2 BRIDGE
X1      10.400    26.000   233.980   271.281     1.000     1.000     1.000      .000      .000      .000
X2        .000      .000      .000   653.560   654.900      .000      .000      .000      .000      .000
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X3     10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000
GR    655.200    233.980    652.780    233.981    651.690    237.180    651.220    240.480    651.020    240.580
GR    650.350    242.980    650.230    243.980    650.080    245.930    653.560    245.931    653.560    246.830
GR    650.010    246.831    649.760    247.980    649.440    250.380    649.610    251.980    649.510    256.880
GR    649.780    258.230    653.560    258.231    653.560    259.130    649.920    259.131    650.060    259.880
GR    650.890    262.680    651.220    263.780    651.290    267.680    652.160    267.780    652.910    271.280
GR    654.900    271.281       .000       .000       .000       .000       .000       .000       .000       .000

X1     10.300       .000       .000       .000     37.900     37.900     37.900       .000       .000       .000
X2       .000       .000       .000    653.560    654.900       .000       .000       .000       .000       .000
X3     10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000

NH      3.000       .030    245.980       .032    259.880       .030    480.520       .000       .000       .000
X1     10.200     59.000    229.190    275.980      1.000      1.000      1.000       .000       .000       .000
GR    656.050       .000    655.820       .010    656.050     16.950    655.770     31.190    655.910     31.191
GR    655.910     59.570    655.820     82.710    655.700     93.890    655.500     96.120    655.400    104.780
GR    655.300    104.781    655.590    136.840    655.170    160.050    655.070    160.051    655.200    175.160
GR    654.860    188.590    655.070    188.591    655.160    193.090    655.050    213.310    655.080    223.460
GR    654.830    229.190    654.550    229.970    652.780    233.980    651.690    237.180    651.220    240.480
GR    651.020    240.580    650.350    242.580    650.230    243.980    650.080    245.980    650.060    246.180
GR    650.010    246.380    649.760    247.980    649.440    250.380    649.610    251.980    649.510    256.880
GR    649.830    258.680    650.060    259.880    650.890    262.680    651.220    263.780    651.290    267.680
GR    652.160    267.780    652.910    271.280    653.760    273.880    654.420    275.980    654.510    282.000
GR    654.500    293.950    654.150    316.370    653.710    344.590    653.480    357.570    653.350    357.571
GR    653.330    375.130    653.680    385.050    653.700    395.410    653.550    406.250    653.680    406.251
GR    654.090    423.310    654.890    442.730    655.620    460.150    656.480    480.520       .000       .000

NC       .000       .000       .000       .200       .400       .000       .000       .000       .000       .000
NH      3.000       .030    245.980       .032    259.880       .030    480.520       .000       .000       .000
X1     10.100       .000       .000       .000     38.000     38.000     38.000       .000       .000       .000
X3     10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000

NH      3.000       .030    183.900       .032    210.250       .030    549.330       .000       .000       .000
X1      9.600     60.000    176.970    220.810    185.000    170.000    175.000       .000       .000       .000
GR    657.320       .000    656.470     10.980    655.920     27.470    655.760     61.550    655.600     83.110
GR    655.400    100.530    655.320    104.710    655.070    106.790    655.110    107.830    654.850    109.950
GR    654.410    131.340    654.700    132.550    654.710    138.950    654.680    158.080    654.520    170.330
GR    654.400    172.610    654.370    174.750    654.350    175.720    654.040    176.970    652.310    179.490
GR    651.620    181.030    650.980    182.480    650.960    183.900    650.220    186.250    650.120    186.780
GR    649.950    188.990    649.820    191.210    649.490    194.690    649.550    197.960    649.580    200.220
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GR    649.550    204.430    649.620    207.030    650.010    208.990    650.220    210.250    650.920    210.910
GR    650.500    212.180    651.060    214.700    651.660    216.240    653.280    219.410    654.040    220.810
GR    654.130    221.740    654.270    228.470    654.180    244.850    654.060    248.870    654.040    267.520
GR    654.050    287.910    654.100    306.520    654.260    306.521    654.350    332.070    654.190    372.450
GR    653.960    410.190    653.860    410.191    653.800    428.390    653.960    428.391    654.290    455.240
GR    654.520    478.540    654.430    490.570    655.630    527.310    656.640    543.400    656.850    549.330

NC       .000       .000       .000       .300       .500       .000       .000       .000       .000       .000
NH      3.000       .030    183.900       .032    210.250       .030    549.330       .000       .000       .000
X1      9.500       .000       .000       .000     20.000     20.000     20.000       .000       .000       .000
X3     10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000

NH      3.000       .030    183.900       .032    210.250       .030    267.520       .000       .000       .000
                 PERRON STREET BRIDGE
X1      9.400     34.000    179.490    216.241      1.000      1.000      1.000       .000       .000       .000
X2       .000       .000       .000    653.400    654.600       .000       .000       .000       .000       .000
X3     10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000
GR    654.560    174.000    654.620    178.000    654.620    179.490    652.310    179.491    651.620    181.030
GR    650.980    181.031    650.960    183.900    650.220    186.250    650.120    186.780    649.950    188.990
GR    649.820    190.760    653.400    190.761    653.400    191.660    649.820    191.661    649.490    194.690
GR    649.550    197.960    649.580    200.220    649.550    203.980    653.400    203.981    653.400    204.880
GR    649.550    204.881    649.620    207.030    650.010    208.990    650.220    210.250    650.920    210.910
GR    650.980    212.180    651.060    214.700    651.660    216.240    654.300    216.241    654.230    220.700
GR    654.270    228.470    654.180    244.850    654.060    248.870    654.040    267.520       .000       .000

X1      9.300       .000       .000       .000     19.600     19.600     19.600       .000       .000       .000
X2       .000       .000       .000    653.400    654.600       .000       .000       .000       .000       .000
X3     10.000       .000       .000       .000       .000       .000       .000       .000       .000       .000

NH      3.000       .030    183.900       .032    210.250       .030    549.330       .000       .000       .000
X1      9.200     60.000    176.970    220.810      5.000      5.000      5.000       .000       .000       .000
GR    657.320       .000    656.470     10.980    655.920     27.470    655.760     61.550    655.600     83.110
GR    655.400    100.530    655.320    104.710    655.070    106.790    655.110    107.830    654.850    109.950
GR    654.410    131.340    654.700    132.550    654.710    138.950    654.680    158.080    654.520    170.330
GR    654.400    172.610    654.370    174.750    654.350    175.720    654.040    176.970    652.310    179.490
GR    651.620    181.030    650.980    182.480    650.960    183.900    650.220    186.250    650.120    186.780
GR    649.950    188.990    649.820    191.210    649.490    194.690    649.550    197.960    649.580    200.220
GR    649.550    204.430    649.620    207.030    650.010    208.990    650.220    210.250    650.920    210.910
GR    650.500    212.180    651.060    214.700    651.660    216.240    653.280    219.410    654.040    220.810
GR    654.130    221.740    654.270    228.470    654.180    244.850    654.060    248.870    654.040    267.520
GR    654.050    287.910    654.100    306.520    654.260    306.521    654.350    332.070    654.190    372.450
GR    653.960    410.190    653.860    410.191    653.800    428.390    653.960    428.391    654.290    455.240
GR    654.520    478.540    654.430    490.570    655.630    527.310    656.640    543.400    656.850    549.330

X1      9.100       .000       .000       .000     38.000     38.000     38.000       .000       .000       .000

NH      4.000       .040     49.400       .030    106.270       .032    136.470       .030    486.210       .000
X1      8.000     57.000     99.270    157.270    255.000    260.000    260.000       .000       .000       .000
X3     10.000       .000       .000       .000       .000    157.270    654.710       .000       .000       .000
GR    660.430       .000    659.550      4.190    658.710      9.450    657.920     14.120    657.070     19.480
GR    656.100     24.980    655.300     29.880    654.790     39.710    654.610     41.960    653.990     45.320
GR    652.980     49.400    652.250     56.060    651.910     71.730    651.740     83.510    651.510     94.400
GR    651.310     99.270    650.810    104.270    650.200    106.270    650.080    107.270    649.760    108.070
GR    649.630    111.070    649.530    116.570    649.530    121.870    649.530    128.970    649.730    131.570
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GR    650.080    136.470    650.270    138.070    651.110    139.570    651.660    141.870    652.380    145.170
GR    653.550    149.270    654.410    152.570    654.710    157.270    654.680    158.470    654.680    167.140
GR    654.490    178.830    654.020    188.520    652.740    194.230    652.120    199.250    652.090    209.310
GR    652.260    223.090    652.640    234.750    652.700    255.300    653.030    278.150    653.350    288.160
GR    654.320    299.460    655.200    308.270    656.390    317.070    656.500    321.940    656.570    326.250
GR    656.490    326.300    656.700    345.720    658.370    399.460    659.120    430.970    659.980    464.750
GR     660.140     464.970     661.400     486.210        .000        .000        .000        .000        .000        .000

NH       3.000        .030      98.160        .032     118.660        .030     475.420        .000        .000        .000
              REDWILLOW PARK FOOTBRIDGE
X1       7.000      65.000      84.400     142.870     180.000     185.000     175.000        .000        .000        .000
X3      10.000        .000        .000        .000        .000     142.870     654.560        .000        .000        .000
GR     661.930      10.530     660.260      13.060     659.190      15.010     657.890      17.740     656.430      22.070
GR     655.870      30.690     655.240      36.060     654.630      51.470     654.280      63.230     653.970      76.260
GR     653.940      84.400     653.200      87.360     652.420      90.160     651.450      93.160     650.770      96.160
GR     650.300      98.160     650.070      98.960     649.810     101.060     649.450     103.060     649.390     105.760
GR     649.590     110.260     649.940     115.560     650.070     118.660     650.300     120.460     651.020     122.050
GR     651.300     126.760     651.510     129.360     652.280     133.160     653.070     135.840     653.700     138.140
GR     654.050     139.370     654.560     142.870     654.220     158.940     653.500     171.290     652.850     186.540
GR     652.880     204.740     653.010     221.230     653.090     237.270     653.340     256.890     653.740     274.040
GR     654.180     288.050     654.190     290.900     654.070     298.050     654.210     304.280     654.300     304.510
GR     654.530     323.190     653.790     344.470     655.110     364.830     655.590     385.830     655.850     407.050
GR     655.690     407.270     656.140     422.900     656.330     431.600     656.570     433.380     656.730     436.020
GR     656.750     436.680     656.910     436.720     657.560     448.930     657.850     459.970     658.220     469.750
GR     658.380     473.360     658.510     473.460     658.550     474.610     658.730     474.630     659.040     475.420

NH       3.000        .040      38.300        .032      64.200        .040     109.320        .000        .000        .000
X1       6.500      29.000       3.100     109.320     172.000     167.000     172.000        .000        .000        .000
GR     660.460       3.100     659.340       3.400     655.750      12.400     651.570      21.100     651.610      21.160
GR     651.380      22.300     651.180      23.300     650.870      24.800     650.650      30.800     650.320      32.300
GR     650.250      38.300     650.090      39.800     649.840      40.500     649.790      42.900     649.290      47.330
GR     649.140      51.200     649.290      55.100     649.560      60.500     650.090      64.200     650.200      65.000
GR     650.650      70.100     650.830      71.200     651.210      74.100     651.490      75.330     656.420      83.200
GR     658.250      88.900     658.440      91.400     659.290      97.820     660.960     109.320        .000        .000

NH       3.000        .040      36.740        .032      64.200        .040     109.320        .000        .000        .000
              C.N.R. BRIDGE
X1       6.400      43.000       3.100     109.320       1.000       1.000       1.000        .000        .000        .000
X2        .000        .000        .000     658.600     660.270        .000        .000        .000        .000        .000
GR     660.460       3.100     659.340       3.400     656.020      11.680     658.600      11.681     658.600      15.260
GR     654.400      15.261     652.600      18.840     658.600      18.841     658.600      22.420     651.350      22.421
GR     650.820      26.000     658.600      26.010     658.600      29.580     650.700      29.581     650.320      33.160
GR     658.600      33.161     658.600      36.740     650.270      36.741     649.950      40.320     658.600      40.321
GR     658.600      47.330     649.290      47.331     649.140      51.200     649.290      55.100     649.560      60.500
GR     650.090      64.200     650.200      65.000     650.400      67.420     658.600      67.421     658.600      70.370
GR     650.700      70.371     651.150      73.950     658.600      73.951     658.600      77.530     652.900      77.531
GR     655.200      81.110     658.600      81.111     658.600      84.690     656.900      84.691     658.250      88.900
GR     658.440      91.400     659.290      97.820     660.960     109.320        .000        .000        .000        .000
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NH       3.000        .040      36.740        .032      64.200        .040     109.320        .000        .000        .000
X1       6.300        .000        .000        .000       6.700       6.700       6.700        .000        .000        .000
X2        .000        .000        .000     658.600     660.270        .000        .000        .000        .000        .000

NH       3.000        .040      38.300        .032      64.200        .040     109.320        .000        .000        .000
X1       6.200      29.000       3.100     109.320       1.000       1.000       1.000        .000        .000        .000
GR     660.460       3.100     659.340       3.400     655.750      12.400     651.570      21.100     651.610      21.160
GR     651.380      22.300     651.180      23.300     650.870      24.800     650.650      30.800     650.320      32.300
GR     650.250      38.300     650.090      39.800     649.840      40.500     649.790      42.900     649.290      47.330
GR     649.140      51.200     649.290      55.100     649.560      60.500     650.090      64.200     650.200      65.000
GR     650.650      70.100     650.830      71.200     651.210      74.100     651.490      75.330     656.420      83.200
GR     658.250      88.900     658.440      91.400     659.290      97.820     660.960     109.320        .000        .000

NH       6.000        .035     120.470        .060     246.430        .050     293.660        .032     346.420        .050
NH     398.800        .035     612.630        .000        .000        .000        .000        .000        .000        .000
X1       5.000      58.000     293.660     363.050     370.000     390.000     380.000        .000        .000        .000
X3      10.000        .000        .000     195.000        .000        .000        .000        .000        .000        .000
GR     658.480        .000     657.330      39.150     656.280      67.860     655.700      76.990     655.310      85.520
GR     655.030      88.670     654.680      92.550     654.200     100.090     653.640     107.070     653.070     114.590
GR     652.840     120.470     652.270     158.700     652.080     185.120     651.970     204.500     651.850     229.750
GR     651.630     246.430     651.360     260.880     650.580     293.660     650.280     300.570     650.110     303.960
GR     649.710     307.780     649.500     309.760     649.440     312.100     649.670     316.650     649.850     322.410
GR     650.030     330.000     649.980     338.170     650.050     342.280     650.260     346.420     650.750     359.580
GR     651.680     361.180     651.970     363.050     652.300     378.030     652.520     389.320     652.110     390.350
GR     651.670     391.400     652.070     394.750     652.580     398.800     653.050     404.830     653.080     406.780
GR     653.090     408.500     653.300     410.360     653.500     436.870     653.750     460.720     653.830     479.900
GR     653.910     487.790     654.000     490.680     654.320     500.060     654.390     503.260     654.910     518.650
GR     655.080     530.890     655.710     556.730     656.170     575.520     656.360     590.860     656.110     596.950
GR     656.000     600.490     656.090     605.960     657.060     612.630        .000        .000        .000        .000

NH       4.000        .035     188.260        .050     398.230        .032     487.060        .150     655.900        .000
X1       4.000      42.000     386.930     497.830     600.000     605.000     600.000        .000        .000        .000
X3      10.000        .000        .000     210.000        .000        .000        .000        .000        .000        .000
GR     659.190        .000     658.140      23.160     657.100      55.220     655.590      89.750     654.270     126.140
GR     653.370     164.260     652.460     188.260     651.770     213.460     651.580     248.390     651.270     285.010
GR     650.990     319.890     651.030     354.050     650.950     375.360     650.830     386.930     650.490     398.230
GR     650.440     406.600     649.970     409.570     649.820     413.370     649.740     422.220     649.650     433.990
GR     649.680     445.660     649.800     456.700     649.890     462.770     649.950     464.950     650.300     470.370
GR     650.530     478.980     650.420     487.060     650.630     492.430     651.060     497.830     651.350     516.030
GR     651.650     531.540     652.090     542.130     653.070     552.760     653.860     563.920     654.440     583.340
GR     654.920     596.790     655.490     608.940     655.600     616.150     656.370     626.510     657.340     637.320
GR     658.010     647.170     658.280     655.900        .000        .000        .000        .000        .000        .000

NH       4.000        .035     553.510        .050     784.430        .032     857.010        .050    1343.510        .000
X1       3.000      63.000     780.430     866.850     595.000     575.000     590.000        .000        .000        .000
X3      10.000        .000        .000     552.000        .000        .000        .000        .000        .000        .000
GR     657.960        .000     657.000      46.010     656.550      90.360     656.570     122.560     656.400     147.560
GR     655.650     184.750     655.160     218.260     654.800     253.600     654.480     291.330     654.340     328.970
GR     653.910     365.560     653.570     406.770     653.800     448.500     652.940     500.020     652.590     536.240
GR     652.410     553.510     652.250     561.990     652.260     590.010     651.990     631.300     651.820     665.450
GR     651.260     691.000     651.180     734.700     651.090     758.560     651.210     765.350     650.840     780.430
GR     650.600     782.700     650.260     784.430     650.370     789.590     650.060     790.930     650.020     794.950
GR     649.730     802.730     649.550     815.290     649.390     826.300     649.650     837.980     650.050     843.630
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GR     650.290     857.010     650.540     862.230     651.160     866.850     651.450     878.060     651.410     892.640
GR     652.450     896.120     653.340     898.920     653.590     903.020     653.420     904.650     653.770     918.450
GR     653.820     926.440     654.160     945.100     654.160     955.850     654.420     985.560     654.740    1029.340
GR     654.720    1064.280     654.480    1092.440     654.560    1134.820     655.260    1186.420     655.400    1217.630
GR     655.510    1224.100     655.740    1227.810     655.640    1232.520     655.780    1235.370     656.070    1268.200
GR     656.400    1301.300     656.570    1330.680     658.860    1343.510        .000        .000        .000        .000

NH       4.000        .035    1048.500        .050    1092.590        .032    1217.130        .060    1401.650        .000
X1       2.000      85.000    1080.020    1236.450     480.000     395.000     395.000        .000        .000        .000
X3      10.000        .000        .000     955.000        .000    1252.950        .000        .000        .000        .000
GR     655.790        .000     655.660      10.260     655.160      47.640     654.830     104.230     654.340     142.590
GR     653.840     185.260     653.100     229.120     653.270     277.680     652.460     312.540     652.020     349.330
GR     652.120     407.100     652.060     452.240     652.190     502.640     652.490     529.290     652.920     535.830
GR     652.640     588.270     652.400     590.060     652.530     633.980     652.650     664.920     653.330     683.500
GR     653.230     699.500     652.790     729.090     652.950     761.010     652.550     805.330     652.160     844.560
GR     651.830     884.890     651.890     921.730     651.660     969.850     651.560    1012.730     651.370    1048.500
GR     650.930    1058.210     651.200    1062.410     651.470    1065.240     651.400    1069.770     651.320    1080.020
GR     650.790    1092.590     650.360    1114.380     650.610    1135.940     650.240    1143.550     650.090    1148.830
GR     649.650    1155.090     649.660    1163.040     649.700    1169.910     649.650    1176.620     649.650    1183.820
GR     649.550    1186.260     649.610    1191.870     649.660    1199.940     650.070    1208.490     650.330    1217.130
GR     650.500    1223.810     651.220    1226.680     652.160    1230.460     652.850    1234.070     653.180    1236.450
GR     653.480    1245.890     653.690    1252.950     653.640    1253.830     653.690    1255.120     653.590    1256.200
GR     653.510    1257.760     653.070    1259.970     652.780    1261.320     652.280    1263.030     651.860    1265.570
GR     651.730    1266.650     651.370    1269.260     651.170    1272.500     651.350    1286.430     651.330    1301.320
GR     651.280    1315.640     651.320    1321.350     651.790    1323.020     652.770    1327.410     653.520    1354.260
GR     655.060    1358.030     654.240    1358.950     654.420    1360.270     653.370    1362.140     653.660    1380.330
GR     653.920    1392.840     655.370    1395.500     655.810    1396.850     654.730    1399.210     654.300    1401.650

NH       5.000        .035    1299.690        .040    1599.060        .032    1691.830        .070    2184.760        .035
NH    2288.500        .000        .000        .000        .000        .000        .000        .000        .000        .000
X1       1.000      82.000    1612.630    1700.040     310.000     710.000     600.000        .000        .000        .000
X3      10.000        .000        .000    1175.000        .000    1726.060        .000        .000        .000        .000
GR     653.870        .000     652.450     114.070     651.590     228.380     650.940     299.160     651.330     391.360
GR     651.900     483.390     652.360     513.930     652.510     558.140     652.120     585.690     652.740     635.680
GR     652.360     657.770     652.600     697.150     652.460     727.230     652.600     772.080     652.410     801.460
GR     652.800     854.080     653.100     891.610     653.540     984.270     653.940    1052.130     653.920    1079.000
GR     653.890    1107.780     653.470    1146.190     653.230    1193.660     652.520    1248.390     652.420    1299.690
GR     651.850    1340.530     651.380    1372.570     651.290    1403.460     651.040    1447.870     650.930    1487.750
GR     650.780    1540.410     650.670    1565.540     650.490    1599.060     650.300    1612.630     649.950    1617.290
GR     649.810    1621.660     649.770    1628.170     649.730    1634.020     649.610    1639.440     649.610    1649.860
GR     649.640    1655.790     649.710    1661.720     649.720    1670.770     650.020    1676.730     649.830    1684.060
GR     650.330    1691.830     650.820    1694.660     651.380    1697.750     651.800    1700.040     652.290    1717.100
GR     652.810    1722.760     653.120    1726.060     653.080    1729.790     652.830    1732.150     652.320    1733.560
GR     651.980    1734.720     651.560    1736.410     650.690    1741.480     650.820    1773.500     650.950    1803.920
GR     651.230    1843.800     651.630    1868.520     651.730    1888.620     652.140    1909.660     652.120    1928.360
GR     651.820    1956.960     651.590    1960.010     651.120    1978.760     651.720    2020.460     651.820    2040.620
GR     651.820    2066.070     651.920    2081.960     652.120    2114.360     652.120    2145.560     651.920    2163.260
GR     652.020    2184.760     652.320    2202.560     652.720    2215.160     654.050    2231.810     655.320    2247.180
GR     656.200    2268.310     657.500    2288.500        .000        .000        .000        .000        .000        .000
EJ        .000        .000        .000        .000        .000        .000        .000        .000        .000        .000
1
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     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

 *PROF 1

 IHLEQ = 1.  THEREFORE FRICTION LOSS (HL) IS CALCULATED AS A FUNCTION OF
 PROFILE TYPE, WHICH CAN VARY FROM REACH TO REACH.  SEE DOCUMENTATION FOR
 DETAILS.

 CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

 CCHV=    .200 CEHV=    .400
 1490 NH CARD USED
 *SECNO 24.000

 3470 ENCROACHMENT STATIONS=      400.0      700.0  TYPE=     1  TARGET=     300.000
     24.00      2.97    651.97    650.61    651.68    651.97       .01       .00       .00    650.16
       92.       41.       26.       25.      176.       46.      138.        0.        0.    649.98
       .00       .23       .57       .18      .045      .033      .070      .000    649.00    400.00
   .000100        0.        0.        0.         0        14         5       .00    300.00    700.00
0
 FLOW DISTRIBUTION FOR SECNO=     24.00          CWSEL=    651.97

 STA=     400.      440.      496.      538.      562.      569.      573.      577.      595.      611.      623.      662.      682.
   PER Q=      11.0      14.3       5.1       4.5       4.0       3.2       2.7      28.3       7.8       5.8       6.9       3.9
    AREA=      43.7      58.1      27.6      19.7      11.2       8.6       7.4      45.9      31.3      23.8      42.1      23.2
     VEL=        .2        .2        .2        .2        .3        .3        .3        .6        .2        .2        .2        .2
 STA=     682.      700.
   PER Q=       2.6
    AREA=      17.1
     VEL=        .1

 1490 NH CARD USED
 *SECNO 23.000

 3470 ENCROACHMENT STATIONS=      360.0      786.4  TYPE=     1  TARGET=    -360.000

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      650.06 ELREA=      653.07

     23.00      2.83    652.01    650.72       .00    652.02       .01       .04       .00    650.06
       92.       64.       28.        0.      282.       58.        0.      163.      132.    653.07
       .42       .23       .49       .00      .048      .032      .070      .000    649.18    360.00
   .000091      470.      470.      445.         0        11         0       .00    267.14    627.14
0
1
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     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

 FLOW DISTRIBUTION FOR SECNO=     23.00          CWSEL=    652.01
```

```
STA-     360.      385.      419.      447.      466.      480.      500.      527.      561.      593.      600.      632.
  PER Q-        5.1       6.2       5.0       4.7       3.5       3.6       8.3      11.6      14.3       7.1      30.7
   AREA-       25.0      31.5      25.7      21.1      15.6      18.3      34.2      46.0      50.7      13.8      57.7
    VEL-         .2        .2        .2        .2        .2        .2        .2        .2        .3        .5        .5

 1490 NH CARD USED
 *SECNO 22.000

 3470 ENCROACHMENT STATIONS=      100.0      335.0  TYPE=     1  TARGET=     235.000
     22.00      3.19    652.06    650.70       .00    652.08       .01       .05       .00    651.67
       92.        7.       52.       33.       33.       84.      147.      280.      224.     650.22
       .69       .22       .62       .23      .035      .036      .067      .000    648.87    100.00
   .000175      305.      525.      440.         0        14         0       .00    235.00    335.00
0
 FLOW DISTRIBUTION FOR SECNO=     22.00          CWSEL=    652.06

 STA=     100.      145.      173.      211.      216.      243.      267.      331.      335.
   PER Q=       5.1       2.6      56.1       3.7      14.3      12.0       5.8        .4
    AREA=      20.9      11.7      83.7       9.0      38.6      33.7      61.2       4.3
     VEL=        .2        .2        .6        .4        .3        .3        .1        .1

 1490 NH CARD USED
 *SECNO 21.000

 3470 ENCROACHMENT STATIONS=      230.0      475.0  TYPE=     1  TARGET=     245.000
     21.00      3.03    652.13    650.63       .00    652.14       .01       .06       .00    650.52
       92.       32.       50.       10.       86.      106.       96.      383.      312.     651.09
       .96       .37       .47       .11      .035      .042      .120      .000    649.10    236.21
   .000134      430.      410.      315.         1        11         0       .00    232.16    468.38
0
 FLOW DISTRIBUTION FOR SECNO=     21.00          CWSEL=    652.13

 STA=     236.      286.      305.      318.      324.      335.      383.      412.      440.      468.
   PER Q=       4.0       6.8      10.0       5.1       8.7      54.1       3.9       4.8       2.6
    AREA=      19.2      18.7      20.4      10.0      17.6     106.3      33.6      37.5      25.0
     VEL=        .2        .3        .5        .5        .5        .5        .1        .1        .1

 1490 NH CARD USED
1
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    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


 *SECNO 20.000

 3470 ENCROACHMENT STATIONS=      330.0      635.1  TYPE=     1  TARGET=    -330.000
     20.00      3.25    652.17    650.63       .00    652.20       .02       .05       .01    650.39
       92.       24.       67.        1.      108.       85.       11.      458.      372.     651.70
      1.10       .23       .79       .05      .077      .032      .150      .000    648.92    355.87
   .000225      285.      325.      315.         0        11         0       .00    164.12    519.99
0
 FLOW DISTRIBUTION FOR SECNO=     20.00          CWSEL=    652.17

 STA=     356.      402.      423.      432.      439.      448.      486.      520.
   PER Q=       6.1       4.1       5.0       4.5       7.0      72.8        .6
    AREA=      44.2      26.1      12.5      10.4      15.1      84.9      11.1
     VEL=        .1        .1        .4        .4        .4        .8        .0

 1490 NH CARD USED
 *SECNO 19.000

 3470 ENCROACHMENT STATIONS=      317.0      488.5  TYPE=     1  TARGET=    -317.000
     19.00      3.23    652.26    650.53       .00    652.28       .02       .08       .00    650.64
       92.        6.       82.        4.       32.      125.       13.      525.      419.     650.86
      1.27       .20       .65       .29      .080      .041      .050      .000    649.03    317.00
   .000228      290.      390.      425.         2        14         0       .00    106.56    423.56
0
 FLOW DISTRIBUTION FOR SECNO=     19.00          CWSEL=    652.26

 STA=     317.      355.      408.      421.      424.
   PER Q=       6.8      89.2       3.9        .1
    AREA=      31.9     125.4      12.1        .8
     VEL=        .2        .7        .3        .1

 1490 NH CARD USED
 *SECNO 18.000
     18.00      3.14    652.32    650.58       .00    652.34       .02       .06       .00    651.05
       92.        0.       78.       13.        2.      123.       48.      570.      446.     651.04
      1.40       .24       .64       .27      .050      .038      .058      .000    649.18     75.83
   .000199      250.      265.      270.         0        18         0       .00     98.72    174.55
0
 FLOW DISTRIBUTION FOR SECNO=     18.00          CWSEL=    652.32

 STA=      76.       79.      134.      147.      165.      173.      175.
   PER Q=        .5      85.2       4.2       5.9       4.0        .2
    AREA=       2.0     123.0      16.3      23.2       7.8        .6
     VEL=        .2        .6        .2        .2        .5        .3

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    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


 1490 NH CARD USED
 *SECNO 17.000
     17.00      3.21    652.39    650.60       .00    652.40       .02       .07       .00    651.06
       92.        4.       84.        4.       15.      141.       25.      628.      478.     650.96
      1.56       .25       .60       .16      .060      .041      .090      .000    649.18     14.76
  .000201     345.      335.      290.         0        14         0       .00    104.85    119.61
0
 FLOW DISTRIBUTION FOR SECNO=      17.00            CWSEL=     652.39

 STA=       15.      30.       92.      110.      120.
   PER Q=       4.1      91.5       3.7        .6
    AREA=      15.3     141.1      20.0       5.4
     VEL=        .2        .6        .2        .1

 CCHV=     .300 CEHV=     .500
 1490 NH CARD USED
 *SECNO 16.500
     16.50      3.16    652.49    650.71       .00    652.54       .05       .12       .02    655.64
       92.        0.       92.        0.        0.       91.        0.      683.      508.     655.40
      1.67       .00      1.01       .00      .060      .032      .090      .000    649.33    133.48
   .000383      400.      400.      395.         1        14         0       .00     43.28    176.76
0
 FLOW DISTRIBUTION FOR SECNO=      16.50            CWSEL=     652.49

 STA=      133.      188.
   PER Q=     100.0
    AREA=      91.5
     VEL=       1.0

 1490 NH CARD USED
 *SECNO 16.400

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  655.40 MAX ELLC=  654.12


 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      655.71 ELREA=      655.41

               BOUDREAU ROAD BRIDGE
1
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     SECNO      DEPTH     CWSEL     CRIWS     WSELK        EG        HV        HL     OLOSS  BANK ELEV
     Q          QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
     TIME       VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
     SLOPE      XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


     16.40      3.16    652.49    650.72       .00    652.54       .06       .00       .00    655.71
       92.        0.       92.        0.        0.       88.        0.      683.      508.     655.41
      1.67       .00      1.05       .00      .060      .030      .090      .000    649.33    133.43
   .000488        1.        1.        1.         0        18         0       .00     41.36    176.79
0
 FLOW DISTRIBUTION FOR SECNO=      16.40            CWSEL=     652.49

 STA=      133.      183.
   PER Q=     100.0
    AREA=      87.9
     VEL=       1.0

 *SECNO 16.300

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  655.40 MAX ELLC=  654.12

     16.30      3.17    652.50    650.72       .00    652.55       .06       .01       .00    655.71
       92.        0.       92.        0.        0.       88.        0.      685.      509.     655.41
      1.68       .00      1.04       .00      .060      .030      .090      .000    649.33    133.40
   .000483       24.       24.       24.         0        18         0       .00     41.43    176.83
0
 FLOW DISTRIBUTION FOR SECNO=      16.30            CWSEL=     652.50

 STA=      133.      183.
   PER Q=     100.0
    AREA=      88.3
     VEL=       1.0

 1490 NH CARD USED
 *SECNO 16.200
     16.20      3.17    652.50    650.71       .00    652.56       .05       .00       .00    655.64
       92.        0.       92.        0.        0.       92.        0.      685.      509.     655.40
      1.68       .00      1.00       .00      .060      .031      .090      .000    649.33    133.39
   .000354        1.        1.        1.         0        14         0       .00     43.45    176.84
0
 FLOW DISTRIBUTION FOR SECNO=      16.20            CWSEL=     652.50

 STA=      133.      188.
   PER Q=     100.0
    AREA=      92.4
     VEL=       1.0

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     SECNO      DEPTH     CWSEL     CRIWS     WSELK        EG        HV        HL     OLOSS  BANK ELEV
     Q          QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
     TIME       VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
     SLOPE      XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST

 CCHV=     .200 CEHV=     .400
 1490 NH CARD USED
 *SECNO 15.000
     15.00      3.68    652.59    650.68       .00    652.60       .01       .04       .01    652.41
       92.        0.       71.       20.        2.       25.      107.      713.      526.     650.89
      1.78       .11       .57       .19      .050      .039      .080      .000    648.91    142.59
   .000153      170.      170.      175.         0        11         0       .00    151.65    294.24
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0
 FLOW DISTRIBUTION FOR SECNO-     15.00           CWSEL-    652.59

 STA-      143.      151.      204.      222.      234.      267.      294.
   PER Q-        .3      77.6       7.5       5.4       7.4       1.9
    AREA-       2.4     125.3      30.9      21.9      38.8      15.5
     VEL-        .1        .6        .2        .2        .2        .1

 1490 NH CARD USED
 *SECNO 14.000
      14.00      3.45    652.63    650.65       .00    652.66       .03       .05       .01    653.42
        92.        0.       91.        1.        0.      117.       20.      763.      558.     651.65
       1.88       .00       .77       .06      .050      .031      .150      .000    649.18     53.98
    .000198      325.      300.      215.         2        18         0       .00    101.21    155.18
0
 FLOW DISTRIBUTION FOR SECNO-     14.00           CWSEL-    652.63

 STA-       54.      106.      155.
   PER Q-      98.6       1.4
    AREA-     117.5      20.0
     VEL-        .8        .1

 1490 NH CARD USED
 *SECNO 13.000
      13.00      3.39    652.67    650.61       .00    652.69       .02       .03       .00    651.34
        92.        2.       77.       12.        9.      118.       40.      795.      578.     651.05
       1.98       .28       .65       .31      .030      .031      .042      .000    649.28    290.78
    .000109      185.      210.      210.         0        18         0       .00     90.61    381.39
0
 FLOW DISTRIBUTION FOR SECNO-     13.00           CWSEL-    652.67

 STA-      291.      308.      351.      363.      376.      381.
   PER Q-       2.7      83.8       9.4       3.5        .6
    AREA-       8.8     117.9      18.7      17.5       4.0
     VEL-        .3        .7        .5        .2        .1

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     SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS   BANK ELEV
     Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA    LEFT/RIGHT
     TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN       SSTA
     SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

 1490 NH CARD USED
 *SECNO 12.400

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA-       654.25 ELREA-       654.23

      12.40      3.32    652.69    650.78       .00    652.73       .04       .03       .01    654.25
        92.        0.       92.        0.        0.      111.        0.      822.      592.     654.23
       2.04       .00       .83       .00      .030      .028      .042      .000    649.37     62.39
    .000216      190.      195.      200.         0        18         0       .00     53.41    115.81
0
 FLOW DISTRIBUTION FOR SECNO-     12.40           CWSEL-    652.69

 STA-       62.      124.
   PER Q-     100.0
    AREA-     110.7
     VEL-        .8

 *SECNO 12.300

 3370 NORMAL BRIDGE,NRD= 16 MIN ELTRD-  654.23 MAX ELLC-  654.26

                REDWILLOW PARK FOOTBRIDGE
      12.30      3.32    652.69    650.78       .00    652.73       .04       .00       .00    654.25
        92.        0.       92.        0.        0.      109.        0.      822.      592.     654.23
       2.04       .00       .84       .00      .030      .028      .030      .000    649.37     62.43
    .000223        1.        1.        1.         0        18         0     -1.29     53.34    115.77
0
 FLOW DISTRIBUTION FOR SECNO-     12.30           CWSEL-    652.69

 STA-       62.      124.
   PER Q-     100.0
    AREA-     109.0
     VEL-        .8

 *SECNO 12.200

 3370 NORMAL BRIDGE,NRD= 16 MIN ELTRD-  654.23 MAX ELLC-  654.26

      12.20      3.32    652.69    650.78       .00    652.73       .04       .00       .00    654.25
        92.        0.       92.        0.        0.      109.        0.      823.      592.     654.23
       2.05       .00       .84       .00      .030      .028      .030      .000    649.37     62.43
    .000223        3.        3.        3.         0        18         0     -1.30     53.34    115.77
0
1
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     SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS   BANK ELEV
     Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA    LEFT/RIGHT
     TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN       SSTA
     SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

 FLOW DISTRIBUTION FOR SECNO-     12.20           CWSEL-    652.69

 STA-       62.      124.
   PER Q-     100.0
    AREA-     109.0
     VEL-        .8

 *SECNO 12.100
      12.10      3.32    652.69    650.78       .00    652.73       .04       .00       .00    654.25
```

```
       92.        0.       92.        0.        0.      110.        0.      823.      592.    654.23
      2.05       .00       .83       .00      .030      .028      .030      .000    649.37     62.43
   .000218        1.        1.        1.         0        18         0       .00     53.34    115.77
0
 FLOW DISTRIBUTION FOR SECNO-     12.10          CWSEL-    652.69

 STA-      62.      124.
   PER Q-    100.0
    AREA-    110.3
     VEL-       .8

 1490 NH CARD USED
 *SECNO 11.000
     11.00      3.63    652.75    650.71       .00    652.79       .04       .06       .00    652.14
       92.        2.       90.        0.        8.       97.        0.      852.      609.    652.77
      2.13       .26       .93       .00      .030      .030      .060      .000    649.12     26.56
   .000248      275.      270.      260.         0        11         0       .00     69.03     95.59
0
 FLOW DISTRIBUTION FOR SECNO-     11.00          CWSEL-    652.75

 STA-      27.       55.       96.
   PER Q-       2.2      97.8
    AREA-       7.7      96.7
     VEL-        .3        .9

 1490 NH CARD USED
 *SECNO 10.600
     10.60      3.40    652.84    651.15       .00    652.91       .07       .10       .01    654.83
       92.        0.       92.        0.        0.       80.        0.      880.      624.    654.42
      2.20       .00      1.15       .00      .030      .029      .030      .000    649.44    233.87
   .000421      266.      306.      331.         1        14         0       .00     37.04    270.91
0
1
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     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


 FLOW DISTRIBUTION FOR SECNO-     10.60          CWSEL-    652.84

 STA-     234.      276.
   PER Q-    100.0
    AREA-     79.7
     VEL-      1.2

 CCHV=    .300 CEHV=    .500
 1490 NH CARD USED
 *SECNO 10.500
     10.50      3.43    652.87    651.14       .00    652.94       .07       .03       .00    654.83
       92.        0.       92.        0.        0.       81.        0.      886.      627.    654.42
      2.22       .00      1.14       .00      .030      .029      .030      .000    649.44    233.79
   .000403       80.       80.       80.         0         8         0       .00     37.28    271.07
0
 FLOW DISTRIBUTION FOR SECNO-     10.50          CWSEL-    652.87

 STA-     234.      276.
   PER Q-    100.0
    AREA-     81.0
     VEL-      1.1

 1490 NH CARD USED
 *SECNO 10.400

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  654.90 MAX ELLC=  653.56


 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      655.20 ELREA=      654.90

           HWY. 2 BRIDGE
     10.40      3.43    652.87    651.31       .00    652.95       .07       .00       .00    655.20
       92.        0.       92.        0.        0.       76.        0.      886.      627.    654.90
      2.22       .00      1.21       .00      .030      .025      .030      .000    649.44    233.98
   .000508        1.        1.        1.         0         9         0       .00     35.34    271.12
0
 FLOW DISTRIBUTION FOR SECNO-     10.40          CWSEL-    652.87

 STA-     234.      271.
   PER Q-    100.0
    AREA-     75.8
     VEL-      1.2

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  09-11-90     15:39:08                                                                                          PAGE   20


     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

 *SECNO 10.300

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  654.90 MAX ELLC=  653.56


 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      655.20 ELREA=      654.90
```

```
     10.30      3.45    652.89    651.31       .00    652.96       .07       .02       .00    655.20
       92.        0.       92.        0.        0.       76.        0.      889.      629.     654.90
      2.23       .00      1.21       .00      .030      .025      .030      .000    649.44    233.98
   .000499       38.       38.       38.         0         9         0       .00     35.39    271.17
0
 FLOW DISTRIBUTION FOR SECNO=      10.30            CWSEL=    652.89

 STA=      234.      271.
   PER Q=    100.0
    AREA=     76.3
     VEL=      1.2

 1490 NH CARD USED
 *SECNO 10.200
     10.20      3.46    652.90    651.15       .00    652.97       .06       .00       .00    654.83
       92.        0.       92.        0.        0.       82.        0.      889.      629.     654.42
      2.23       .00      1.12       .00      .030      .029      .030      .000    649.44    233.71
   .000386        1.        1.        1.         1         9         0       .00     37.51    271.22
0
 FLOW DISTRIBUTION FOR SECNO=      10.20            CWSEL=    652.90

 STA=      234.      276.
   PER Q=    100.0
    AREA=     82.2
     VEL=      1.1

 CCHV=     .200 CEHV=     .400
 1490 NH CARD USED
 *SECNO 10.100
1
  09-11-90      15:39:08                                                                                    PAGE   21


    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=       654.83 ELREA=       654.42

     10.10      3.48    652.92    651.15       .00    652.98       .06       .01       .00    654.83
       92.        0.       92.        0.        0.       83.        0.      893.      630.     654.42
      2.24       .00      1.11       .00      .030      .029      .030      .000    649.44    233.66
   .000375       38.       38.       38.         0         9         0       .00     37.65    271.31
0
 FLOW DISTRIBUTION FOR SECNO=      10.10            CWSEL=    652.92

 STA=      234.      276.
   PER Q=    100.0
    AREA=     83.1
     VEL=      1.1

 1490 NH CARD USED
 *SECNO 9.600
      9.60      3.50    652.99    650.87       .00    653.03       .04       .04       .00    654.04
       92.        0.       92.        0.        0.      106.        0.      909.      637.     654.04
      2.30       .00       .87       .00      .030      .030      .030      .000    649.49    178.50
   .000195      185.      175.      170.         8        18         0       .00     40.33    218.84
0
 FLOW DISTRIBUTION FOR SECNO=       9.60            CWSEL=    652.99

 STA=      179.      221.
   PER Q=    100.0
    AREA=    105.8
     VEL=       .9

 CCHV=     .300 CEHV=     .500
 1490 NH CARD USED
 *SECNO 9.500

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=       654.04 ELREA=       654.04

      9.50      3.51    653.00    650.87       .00    653.04       .04       .00       .00    654.04
       92.        0.       92.        0.        0.      106.        0.      911.      638.     654.04
      2.30       .00       .87       .00      .030      .030      .030      .000    649.49    178.49
   .000192       20.       20.       20.         0        18         0       .00     40.38    218.86
0
1
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    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST

 FLOW DISTRIBUTION FOR SECNO=       9.50            CWSEL=    653.00

 STA=      178.      221.
   PER Q=    100.0
    AREA=    106.3
     VEL=       .9

 1490 NH CARD USED
 *SECNO 9.400

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  654.60 MAX ELLC=  653.40


 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=       654.62 ELREA=       654.30

           PERRON STREET BRIDGE
      9.40      3.50    652.99    650.91       .00    653.04       .05       .00       .00    654.62
       92.        0.       92.        0.        0.       98.        0.      911.      638.    654.30
      2.30       .00       .94       .00      .030      .031      .030      .000    649.49    179.49
   .000369        1.        1.        1.         0        15         0       .00     34.95    216.24
0
 FLOW DISTRIBUTION FOR SECNO=      9.40           CWSEL=    652.99

 STA=     179.      216.
   PER Q=     100.0
    AREA=      97.7
     VEL=        .9

 *SECNO 9.300

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD=  0 MIN ELTRD=  654.60 MAX ELLC=  653.40


 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      654.62 ELREA=      654.30

      9.30      3.51    653.00    650.91       .00    653.05       .05       .01       .00    654.62
       92.        0.       92.        0.        0.       98.        0.      913.      639.    654.30
      2.31       .00       .94       .00      .030      .031      .030      .000    649.49    179.49
   .000368       20.       20.       20.         0        15         0       .00     34.95    216.24
0
1
  09-11-90     15:39:08                                                                                    PAGE   23

     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST

 FLOW DISTRIBUTION FOR SECNO=      9.30           CWSEL=    653.00

 STA=     179.      216.
   PER Q=     100.0
    AREA=      97.8
     VEL=        .9

 1490 NH CARD USED
 *SECNO 9.200
      9.20      3.52    653.01    650.87       .00    653.05       .04       .00       .00    654.04
       92.        0.       92.        0.        0.      106.        0.      914.      639.    654.04
      2.31       .00       .86       .00      .030      .030      .030      .000    649.49    178.48
   .000191        5.        5.        5.         0        18         0       .00     40.39    218.87
0
 FLOW DISTRIBUTION FOR SECNO=      9.20           CWSEL=    653.01

 STA=     178.      221.
   PER Q=     100.0
    AREA=     106.5
     VEL=        .9

 *SECNO 9.100
      9.10      3.53    653.02    650.87       .00    653.06       .04       .01       .00    654.04
       92.        0.       92.        0.        0.      107.        0.      918.      640.    654.04
      2.32       .00       .86       .00      .030      .030      .030      .000    649.49    178.45
   .000187       38.       38.       38.         0        18         0       .00     40.46    218.91
0
 FLOW DISTRIBUTION FOR SECNO=      9.10           CWSEL=    653.02

 STA=     178.      221.
   PER Q=     100.0
    AREA=     107.2
     VEL=        .9

 1490 NH CARD USED
 *SECNO 8.000

 3470 ENCROACHMENT STATIONS=        .0     157.3  TYPE=     1  TARGET=     157.269

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      651.31 ELREA=      654.71

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     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


      8.00      3.55    653.08    650.63       .00    653.09       .01       .03       .01    651.31
       92.       18.       74.        0.       57.      135.        0.      957.      658.    654.71
      2.47       .32       .55       .00      .030      .030      .030      .000    649.53     49.04
   .000070      255.      260.      260.         0        17         0       .00     98.55    147.59
0
 FLOW DISTRIBUTION FOR SECNO=      8.00           CWSEL=    653.08

 STA=      49.       72.       84.       94.       99.      157.
   PER Q=       5.2       5.1       6.1       3.4      80.1
    AREA=      18.5      14.7      15.7       8.1     134.6
     VEL=        .3        .3        .4        .4        .5

 1490 NH CARD USED
 *SECNO 7.000

 3470 ENCROACHMENT STATIONS=        .0     142.9  TYPE=     1  TARGET=     142.869

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=              ELREA=      654.56

              REDWILLOW PARK FOOTBRIDGE
      7.00      3.70   653.09   650.95      .00   653.12      .03      .02      .01   653.94
       92.        0.      92.       0.       0.     113.       0.     983.     671.   654.56
      2.53       .00      .81      .00     .030     .029     .030     .000   649.39    87.74
   .000183      180.     175.     185.        1       14        0      .00    48.19   135.93
0
 FLOW DISTRIBUTION FOR SECNO-      7.00          CWSEL-    653.09

 STA-       88.      143.
   PER Q-   100.0
    AREA-   112.9
     VEL-      .8

 1490 NH CARD USED
 *SECNO 6.500
      6.50      3.99   653.13   650.62      .00   653.15      .02      .02      .01   660.46
       92.        0.      92.       0.       0.     167.       0.    1007.     681.   660.96
      2.61       .00      .55      .00     .030     .033     .030     .000   649.14    17.85
   .000087      172.     172.     167.        2       18        0      .00    60.10    77.95
0
1
  09-11-90     15:39:08                                                                                     PAGE   25

     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST

 FLOW DISTRIBUTION FOR SECNO-      6.50          CWSEL-    653.13

 STA-       18.      109.
   PER Q-   100.0
    AREA-   167.3
     VEL-      .5

 1490 NH CARD USED
 *SECNO 6.400

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD-  0 MIN ELTRD-  660.27 MAX ELLC-  658.60

              C.N.R. BRIDGE
      6.40      3.98   653.12   650.80      .00   653.16      .04      .00      .01   660.46
       92.        0.      92.       0.       0.     108.       0.    1008.     681.   660.96
      2.61       .00      .86      .00     .030     .031     .030     .000   649.14    17.79
   .000337        1.       1.       1.        1       22        0      .00    35.81    77.88
0
 FLOW DISTRIBUTION FOR SECNO-      6.40          CWSEL-    653.12

 STA-       18.      109.
   PER Q-   100.0
    AREA-   107.5
     VEL-      .9

 1490 NH CARD USED
 *SECNO 6.300

 3265 DIVIDED FLOW


 3370 NORMAL BRIDGE,NRD-  0 MIN ELTRD-  660.27 MAX ELLC-  658.60

      6.30      3.98   653.12   650.80      .00   653.16      .04      .00      .00   660.46
       92.        0.      92.       0.       0.     107.       0.    1008.     681.   660.96
      2.61       .00      .86      .00     .030     .031     .030     .000   649.14    17.80
   .000338        7.       7.       7.        0       22        0      .00    35.80    77.88
0
1
  09-11-90     15:39:08                                                                                     PAGE   26

     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST

 FLOW DISTRIBUTION FOR SECNO-      6.30          CWSEL-    653.12

 STA-       18.      109.
   PER Q-   100.0
    AREA-   107.4
     VEL-      .9

 1490 NH CARD USED
 *SECNO 6.200
      6.20      4.01   653.15   650.63      .00   653.17      .02      .00      .01   660.46
       92.        0.      92.       0.       0.     169.       0.    1008.     681.   660.96
      2.61       .00      .55      .00     .030     .033     .030     .000   649.14    17.81
   .000085        1.       1.       1.        2       18        0      .00    60.18    77.98
0
 FLOW DISTRIBUTION FOR SECNO-      6.20          CWSEL-    653.15

 STA-       18.      109.
   PER Q-   100.0
    AREA-   168.6
     VEL-      .5

 1490 NH CARD USED
 *SECNO 5.000

 3470 ENCROACHMENT STATIONS-     195.0      612.6  TYPE-     1  TARGET-    -195.000
      5.00      3.74   653.18   650.64      .00   653.19      .0[illegible]      .01      .00   650.58
       92.       23.      66.       4.     164.     211.      3[illegible]    1118.     733.   651.97
      3.02       .14      .31      .10     .053     .034     .04[illegible]     .000   649.44   195.00
   .000025     370.     380.     390.        2       17        0      .00   214.32   409.32
0
 FLOW DISTRIBUTION FOR SECNO-     5.00          CWSEL-   653.18

 STA-     195.     230.     261.     294.     363.     395.     409.
   PER Q-      4.5      6.6     13.5     71.4      3.4       .5
    AREA-     43.4     48.4     72.5    210.7     31.0      6.1
     VEL-       .1       .1       .2       .3       .1       .1

 1490 NH CARD USED
 *SECNO 4.000

 3470 ENCROACHMENT STATIONS-     210.0     655.9  TYPE-     1  TARGET-    -210.000
1
  09-11-90     15:39:08                                                                                       PAGE   27


    SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS   BANK ELEV
    Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA    LEFT/RIGHT
    TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
    SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


     4.00     3.54   653.19   650.39      .00   653.19      .00      .01      .00   650.83
      92.      31.      59.       2.     343.     341.      83.    1472.     901.    651.06
     4.19      .09      .17      .03     .050     .035     .150     .000   649.65   210.00
  .000008     600.     600.     605.        2       17        0      .00   344.50   554.50
0
 FLOW DISTRIBUTION FOR SECNO-     4.00          CWSEL-   653.19

 STA-     210.     248.     285.     320.     354.     375.     387.     498.     554.
   PER Q-      4.6      5.9      7.2      7.8      4.9      2.9     64.3      2.4
    AREA-     57.8     64.7     72.0     74.6     46.9     26.6    340.5     83.1
     VEL-       .1       .1       .1       .1       .1       .1       .2       .0

 1490 NH CARD USED
 *SECNO 3.000

 3470 ENCROACHMENT STATIONS-     552.0    1343.5  TYPE-     1  TARGET-    -552.000
     3.00     3.81   653.20   650.36      .00   653.20      .00      .01      .00   650.84
      92.      30.      57.       5.     349.     282.      52.    1900.    1105.    651.16
     5.22      .09      .20      .09     .050     .033     .050     .000   649.39   552.00
  .000009     595.     590.     575.        0       14        0      .00   346.49   898.49
0
 FLOW DISTRIBUTION FOR SECNO-     3.00          CWSEL-   653.20

 STA-     552.     631.     665.     691.     735.     759.     780.     867.     893.     898.
   PER Q-      5.4      3.5      4.0      9.1      5.4      5.2     62.4      4.7       .4
    AREA-     79.7     44.3     42.5     86.7     49.3     46.8    281.8     47.1      5.3
     VEL-       .1       .1       .1       .1       .1       .1       .2       .1       .1

 1490 NH CARD USED
 *SECNO 2.000

 3470 ENCROACHMENT STATIONS-     955.0    1252.9  TYPE-     1  TARGET-     297.950
     2.00     3.65   653.20   650.33      .00   653.20      .00      .00      .00   651.32
      92.      21.      71.       0.     214.     449.       0.    2190.    1244.    653.18
     6.02      .10      .16      .00     .039     .033     .060     .000   649.55   955.00
  .000007     480.     395.     395.        0       17        0      .00   282.14  1237.14
0
 FLOW DISTRIBUTION FOR SECNO-     2.00          CWSEL-   653.20

 STA-     955.    1013.    1049.    1065.    1080.    1236.
   PER Q-      9.7      7.2      3.1      2.3     77.7
    AREA-     90.6     62.1     34.2     26.9    448.8
     VEL-       .1       .1       .1       .1       .2

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    SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS   BANK ELEV
    Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA    LEFT/RIGHT
    TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
    SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST

 1490 NH CARD USED
 *SECNO 1.000

 3470 ENCROACHMENT STATIONS-    1175.0    1726.1  TYPE-     1  TARGET-     551.060
     1.00     3.59   653.20   650.31      .00   653.21      .00      .00      .00   650.30
      92.      54.      37.       1.     700.     288.      24.    2561.    1411.    651.80
     7.39      .08      .13      .03     .039     .033     .070     .000   649.61  1195.49
  .000004     310.     600.     710.        0       21        0      .00   530.57  1726.06
0
 FLOW DISTRIBUTION FOR SECNO-     1.00          CWSEL-   653.20

 STA-    1195.    1341.    1373.    1403.    1448.    1488.    1540.    1566.    1599.    1613.    1700.    1726.
   PER Q-      4.7      3.6      4.5      7.5      7.8     11.3      5.9      8.7      4.9     40.3       .7
    AREA-     99.7     51.0     57.8     90.7     88.6    123.8     62.4     88.0     38.1    287.7     24.3
     VEL-       .0       .1       .1       .1       .1       .1       .1       .1       .1       .1       .0

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                                                                                   THIS RUN EXECUTED 09-11-90
 **************************************************
   HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
   ERROR CORR -  01,02,03,04,05,06
   MODIFICATION -  50,51,52,53,54,55,56
   IBM-PC-XT VERSION AUGUST 1985
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

B Yaremko  filename - ST

SUMMARY PRINTOUT

     SECNO      CWSEL      CRIWS       EG        XLCH       K*XNL     K*XNCH      K*XNR      QLOB       QCH       QROB

    24.000     651.97     650.61     651.97        .00      45.00      32.67      70.00      41.17      26.05     24.78
    23.000     652.01     650.72     652.02     470.00      48.17      32.19      70.00      63.76      28.24       .00
    22.000     652.06     650.70     652.08     525.00      35.00      35.82      66.96       7.16      51.60     33.24
    21.000     652.13     650.63     652.14     410.00      35.00      41.91     120.00      31.83      49.80     10.37
    20.000     652.17     650.63     652.20     325.00      76.67      32.29     150.00      24.47      66.98       .55
    19.000     652.26     650.53     652.28     390.00      80.00      40.91      50.00       6.23      82.04      3.72
    18.000     652.32     650.58     652.34     265.00      50.00      37.73      58.35        .47      78.41     13.12
    17.000     652.39     650.60     652.40     335.00      60.00      41.27      90.00       3.78      84.20      4.02
    16.500     652.49     650.71     652.54     400.00      60.00      31.68      90.00        .00      92.00       .00
    16.400     652.49     650.72     652.54       1.00      60.00      30.42      90.00        .00      92.00       .00
    16.300     652.50     650.72     652.55      24.00      60.00      30.43      90.00        .00      92.00       .00
    16.200     652.50     650.71     652.56       1.00      60.00      30.89      90.00        .00      92.00       .00
    15.000     652.59     650.68     652.60     170.00      50.00      38.55      80.00        .26      71.42     20.32
    14.000     652.63     650.65     652.66     300.00      50.00      30.94     150.00        .00      90.71      1.29
    13.000     652.67     650.61     652.69     210.00      30.00      30.99      42.13       2.47      77.12     12.41
    12.400     652.69     650.78     652.73     195.00      30.00      28.40      42.13        .00      92.00       .00
    12.300     652.69     650.78     652.73       1.00      30.00      28.39      30.00        .00      92.00       .00
    12.200     652.69     650.78     652.73       3.00      30.00      28.39      30.00        .00      92.00       .00
    12.100     652.69     650.78     652.73       1.00      30.00      28.40      30.00        .00      92.00       .00
    11.000     652.75     650.71     652.79     270.00      30.00      29.64      60.00       2.04      89.96       .00
    10.600     652.84     651.15     652.91     306.00      30.00      28.82      30.00        .00      92.00       .00
    10.500     652.87     651.14     652.94      80.00      30.00      28.82      30.00        .00      92.00       .00
    10.400     652.87     651.31     652.95       1.00      30.00      24.95      30.00        .00      92.00       .00
    10.300     652.89     651.31     652.96      37.90      30.00      24.93      30.00        .00      92.00       .00
    10.200     652.90     651.15     652.97       1.00      30.00      28.82      30.00        .00      92.00       .00
    10.100     652.92     651.15     652.98      38.00      30.00      28.82      30.00        .00      92.00       .00
     9.600     652.99     650.87     653.03     175.00      30.00      29.76      30.00        .00      92.00       .00
     9.500     653.00     650.87     653.04      20.00      30.00      29.76      30.00        .00      92.00       .00
     9.400     652.99     650.91     653.04       1.00      30.00      31.22      30.00        .00      92.00       .00
     9.300     653.00     650.91     653.05      19.60      30.00      31.22      30.00        .00      92.00       .00
     9.200     653.01     650.87     653.05       5.00      30.00      29.76      30.00        .00      92.00       .00
     9.100     653.02     650.87     653.06      38.00      30.00      29.76      30.00        .00      92.00       .00
     8.000     653.08     650.63     653.09     260.00      30.00      29.97      30.00      18.27      73.73       .00
     7.000     653.09     650.95     653.12     175.00      30.00      28.97      30.00        .00      92.00       .00
     6.500     653.13     650.62     653.15     172.00      30.00      33.15      30.00        .00      92.00       .00
     6.400     653.12     650.80     653.16       1.00      30.00      30.56      30.00        .00      92.00       .00
     6.300     653.12     650.80     653.16       6.70      30.00      30.57      30.00        .00      92.00       .00
     6.200     653.15     650.63     653.17       1.00      30.00      33.16      30.00        .00      92.00       .00
     5.000     653.18     650.64     653.19     380.00      52.97      33.80      49.27      22.64      65.73      3.62
     4.000     653.19     650.39     653.19     600.00      50.00      34.65     150.00      30.65      59.15      2.21
     3.000     653.20     650.36     653.20     590.00      49.97      33.14      50.00      29.95      57.38      4.67
     2.000     653.20     650.33     653.20     395.00      38.60      32.84      60.00      20.53      71.47       .00
     1.000     653.20     650.31     653.21     600.00      39.14      32.56      70.00      54.22      37.11       .68
1
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 SUMMARY OF ERRORS AND SPECIAL NOTES

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 09-11-90     15:41:28                                                                                                PAGE    1



**********************************************                                  THIS RUN EXECUTED 09-11-90
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
  IBM-PC-XT VERSION AUGUST 1985
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MAPS
NOT
FILMED

CARTES
OMISES